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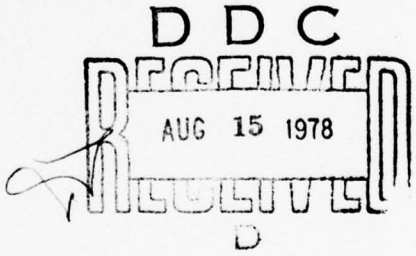

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This is a monthly publication presenting brief articles concerning recent developments in European Scientific Research. It is hoped that these articles (which do not constitute part of the scientific literature) may prove of value to American scientists by disclosing interesting information well in advance of the usual scientific publications.

The articles are written primarily by members of the staff of ONRL, with certain articles prepared by, or in cooperation with, members of the scientific

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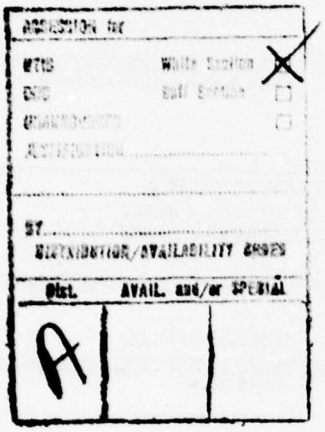

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Aubrey W. Pryce and Victoria S. Hewitson

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AEROSPACE

SPACE TECHNOLOGY AT THE ROYAL AIRCRAFT ESTABLISHMENT

Farnborough, England, is world renowned for its biennial international air show featuring a public display of a wide variety of military and civil aircraft from virtually every nation involved in aircraft production. Recent displays covered the gamut from the Concorde SST to the highly classified SR-71 reconnaissance aircraft. The organization sponsoring the air show is the Royal Aircraft Establishment, which has its main facility at Farnborough. RAE is one of the world's foremost areospace research centers and dates back to 1878 when the British War Office sponsored the formation of the Balloon Equipment Store. The Store was the embryo organization from which both the RAE and the Royal Air Force directly grew. Its mission was to demonstrate the use of observation balloons in various military exercises. In 1902 the Balloon Store began work on powered aircraft and its location moved from the Woolwich Arsenal to Farnborough. In 1908 the first British airplane was built and flown there. The aircraft was a power-driven man-carrying biplane and traveled a distance of 496 yds. Aviation research continued, and in 1918 part of the original Balloon Store officially became the RAE.

Today, RAE is the Air Systems Establishment of the Ministry of Defence (MOD) with overall responsibility for the conduct and co-ordination of research and development in all military aerospace activities except engines and radar. RAE also provides support for civil aviation and space programs with the funding being provided primarily by the Department of Industry (DOI). In many cases when research programs serve both defense and civil interests, they are jointly funded. The primary mission of the Establishment is to develop and maintain an expertise over a wide range of disciplines that are fundamental to aerospace technology. This expertise is deployed in a variety of tasks in support of the military services, government agencies, and industry. It extends from research and the conceptual stages of aerospace projects to the evolution of new operational techniques and the trouble-shooting of programs in service. Particular emphasis is placed on the rapid and effective transfer of technology to industry.

During the 1950s, research and development on missiles at RAE laid the foundation for the entry of the UK into the space age. An offshoot of this original R&D was the Skylark upper atmosphere sounding rocket that is still in production and one of the bread-and-butter programs for British Aerospace. Later, work on ballistic missiles saw the development of the Black Arrow rocket, a three-stage vehicle capable of placing a small payload in low earth orbit. The Black Arrow program was terminated in 1971 after the successful launch of a UK technology satellite. This RAE satellite, named Prospero, had a mass of 66 kg and was placed in a 544 × 1573 km orbit. Its mission was to test a new type of solar cell and thermal coating, measure micrometeorite fluxes, and demonstrate the UK's ability to orbit a satellite. Since 1967, RAE has played a leading role in the development and operation of a number of research satellites as part of both UK and collaborative programs, and the British defense communications satellite, Skynet, launched in 1974.

The scientific staff of RAE is currently grouped into 13 technical departments under three deputy directors with each department comprised of about 100 scientists and engineers. The Space Department is divided into four major divisions: Space Systems; Electronic and Data Handling; Propulsion; and Opto Mechanical. About 70% of the technical staff is involved in programs directly related to space science and technology, and the remaining 30% is working on space related programs including laser gyros, fiber optics, cockpit displays, and ir propagation. In the area of directly related satellite technology, heavy emphasis is being placed on communications and remote sensing payloads, electrothermal hydrazine thrusters, solid-state sensors, NATO IV satellite system analysis, and NAVSTAR (DoD global positioning satellite system) vulnerability analysis. Test facilities include three thermal vacuum chambers, a Large Area Pulsed Solar Simulator (LAPSS) facility, a magnetic test laboratory, a satellite attitude-control test laboratory, and a star-sensor test facility.

In addition, RAE operates a satellite antenna test range and satellite control center at nearby Lasham.

The program direction taken by the Space Department is, not surprisingly, dictated by its several funding agencies. Two decisions taken by the government in the last five years have significantly influenced this funding. The first was the termination of the Skynet military satellite communications program, and the second was that all civil space programs in the UK would be accomplished through the European Space Agency (ESA) of which Britain is a member and strong financial contributor. Thus the UK has no official national space program or agency. As a result, the Space Department obtains funding for military-oriented space projects such as NATO IV studies from the MOD, civil-oriented programs such as remote sensing payloads development from the DOI, and basic research programs such as the Ariel scientific satellite from the Science Research Council. DOI is particularly interested in maintaining the capability of the British aerospace industry in space technology at a level that will enable it to compete successfully for ESA and other foreign contracts. This is accomplished through funded research at RAE and other national research centers.

One of the interesting R&D programs underway in the Space Department is the development of a new star sensor that is intended to remove both bias and drift from a satellite attitude control system by periodically referring the attitude of the spacecraft to reference stars. The sensor, which is based on the latest CCD (charged-coupled device) technology, is designed to detect stars of intensities down to $m_v \leq +4$ with a measuring accuracy of a few arc seconds. Current methods of maintaining earth pointing of a satellite are through the use of earth sensors with typical accuracies of around 0.1 degree. It is not expected that this accuracy can be improved significantly using earth sensors only, particularly for satellites in low earth orbit. The system envisaged by RAE would be based on a set of high-grade integrating rate gyroscopes to form the main attitude reference, with the star sensors providing a means of removing initial satellite errors and subsequent drifts from this reference. The star sensor incorporates a 1024-element linear CCD array mounted in the focal plane of a specially developed optical system. The linear dimensions of the CCD array provides a field of view of 3° × 30 arc sec. This field of view will be aligned in the satellite in such a manner that the image of predetermined stars formed by the optical system will cross it owing to the pitch rotation of the satellite. Signals produced by the sensor due to the star image will provide two distinct pieces of information—the position along the array at which the image crossing occurred and the associated time of the particular star transit. This attitude data is then compared in the control-system processor against the predicted crossing position and time for a particular star based on a no-attitude control error situation. Deviations from these values are then used to provide estimates of the satellite attitude error and of the drifts existing in the inertial reference and permit the necessary corrections to be carried out. Two sensors suitably oriented in the satellite must be used to assure unambiguous determination of attitude. Initial simulation of the system indicates that each sensor should be capable of providing a minimum of five star fixes per orbit. The current prototype sensor will provide this information. An improved version of the sensor is being constructed for the environmental qualification model.

In the area of communications payload technology, RAE is attempting to develop an in-house expertise which until recently has been minimal. This effort is primarily in response to DOI and ESA program emphasis. Senior engineers with expertise in other technologies have been diverted to satellite communications payload development. Most of these people have been involved in other types of communications research and have been able to establish a rather respectable satellite program in a relatively short time. Four specific areas are under investigation: phased-array communications antennas; transistor power amplifiers; low-noise receivers; and VHF antennas for TT&C (tracking, telemetry, and command). Significant progress has been made, and breadboard models of the power amplifiers and receivers have been achieved.

With regard to remote sensing, a good deal of effort is being expended to establish RAE as a national center for remote sensing. It is currently designated as the "National Point of

Contact for the UK" in this regard. DOI has stimulated this interest as a result of its participation in the ESA remote sensing program. About a year ago, ESA started looking for European satellite ground stations that could receive and analyze data from such remote sensing satellites as SEASAT, LANDSAT, and METEOSAT. The UK had such a facility at Oakhanger that had been used in conjunction with the now defunct Skynet program. The facility, which is under the control of MOD, has been "donated" to RAE in pursuit of its civil remote sensing program. It is currently being modified to receive the appropriate data and to feed this to a computer analysis facility being added at RAE. RAE will be responsible for taking the data and stimulating interest in its use by various customers in the UK.

The trends evidenced by RAE's remote sensing program are encouraging in that they could lead to a centralized national space program with a planned direction under one entity such as CNES in France and DFVLR in Germany. RAE certainly has the experience and expertise to assume such a role which would be good not only for itself but also for the British space industry—a feeling widespread within the UK space community. (Robert W. Rostron)

EARTH SCIENCES

TWO UK ACOUSTIC MEETINGS —UNDERWATER ACOUSTICS TO THE FORE —OR WITH BREKHOVSKIKH IN ENGLAND

In early April the UK's Institute of Acoustics (IOA) held two highly successful meetings which clearly demonstrated its growing stature and capability. The Annual Spring Meeting on 4-7 April at Cambridge emphasized the fields of Aerodynamic Noise, Vibration and Acoustics, Building Acoustics, and Speech Research. The second meeting on 10 and 11 April was at the Imperial College of Science and Technology in London on the subject of Sound Propagation and Underwater Systems.

Earlier *ESN* articles (30-12:545 and 31-6:245) have outlined the growth and development of the IOA in terms of membership, organization and activity. Particular note was made of the successful Spring Meeting held at Bath in April 1977. This year's Spring Meeting, attended by one of us (AWP), moved the IOA on to new heights. Thanks to the energy and enthusiasm of the local organizer, Prof. J.E. Ffowcs-Williams, and the support of Prof. Sir James Lighthill, FRS, the IOA achieved its most successful and rewarding general meeting. Attendance at Cambridge reached 250 as compared with 150 at Bath. Whereas Bath was very much a UK meeting, about 1 in 7 of the Cambridge attendees were from overseas including the US, Scandanavia, the Benelux countries, the FRG, France, Poland, the USSR, and Singapore. A total of 130 papers were delivered as compared with 40, and of these 1 in 5 were by overseas contributors. Four parallel sessions were required to complete the program in its scheduled three days.

As at Bath, a series of invited lectures were included in such a manner that they did not conflict with regular sessions. Speakers were: Dr. F. Fallside (Univ. of Cambridge), "Speech Research and the Handicapped"; Prof. R.B. Newman (Harvard Univ. and MIT), "To Hear or Not to Hear"; Prof. Sir James Lighthill (Univ. of Cambridge), "Acoustical Streaming"; and Prof. M. Heckl (Tech. Univ. of Berlin), "Excitation and Damping of Plate Vibration by Moving Media." To these lectures must be added the Presidential Address given by Prof. E.R. Dobbs (Bedford College, London) entitled "The Inaudible Helium Quintet," and the Rayleigh lecture, "Acoustics and the Ocean," delivered by Academician L.M. Brekhovskikh of the USSR on the occasion of the award to him of the IOA's premier Medal for his outstanding contributions to wave theory. Brekhovshikh is well known in the West for his authoritative books, *Waves in a Layered Media* which was first translated into English in 1960, and *Acoustics of the Ocean*, (1974), which he edited. He is Chairman of both the USSR's Academy of Science Scientific Council on Acoustics and of its Oceanological Commission.

Unfortunately the only hitch at the Meeting was associated with Brekhovskikh's attendance. To start the meeting with a bang the Award was to have been the opening event, but the time arrived and Brekhovskikh was still in Moscow. While the organizers took

it all in their stride, rescheduling the Award for the afternoon of the 6th after his arrival, Brekhovskikh missed among other sessions a short one on underwater sound planned to follow his talk on the first morning. This "happening" or "nonhappening" is worthy of note as a guide to other meeting organizers who may have similar designs.

No attempt will be made to review the 130 papers. They are to be printed as extended summaries in an annual issue of IOA Proceedings, which will replace a loose-leaf collection of summaries previously issued to members on an availability basis. Some comment on Brekhovskikh's paper is in order, however, since when it appears it will be in a long-promised volume of Special Lectures. His talk differed somewhat from the paper, "The Ocean as an Acoustical Medium," he gave in July 1977 at the 9th International Congress in Acoustics in Madrid, in being more concerned with Russian research in the field and by being a more personal account.

After acknowledging the award on behalf of both his colleagues and himself for work over a 35-year period, he noted that USSR study on propagation of sound in the sea started in the Black Sea in 1942 when it was aimed at developing methods of countering German mines. These experiments were paralleled by the initiation of theoretical work on layered media. Work in the Japanese Sea in 1946 led to the "discovery" of sound channeling due to upward refraction and repeated reflection from the surface. This was considered analogous to the whispering gallery effect, Rayleigh's theory of which was applied to the explanation of some of the phenomena observed in the channel, for example, the pulse shape received at a distance which exhibits a slow rise in intensity and a rapid cut-off. Brekhovskikh expressed continuing interest in the whispering gallery effect and cited as examples St. Paul's in London, the San Susi benches in Potsdam, and the Temple of Heaven in Peking. In 1960 systematic USSR ocean research began in the Atlantic. After discussing a typical transmission run from a shallow source to a deeper receiver showing the importance of both bottom reflection and convergent zones (at approx. 55, 110,165...km), he considered the effects of individual ocean features, e.g., the primary dependence of bottom reflection (vertical) on bottom relief rather than on material, and the dependence of back-scattering on frequency and angle for a relatively smooth bottom, with little dependence on angle for a rough one. Following with sea-surface scattering and the development of theory for the case where the scale of roughness is large compared with the wavelength, he went on to talk of scattering layers and of their diurnal migration, and how the contributors could be separated by the use of various frequencies into fish dimensions on a basis of resonance. His examples showed fish of different dimensions moving in opposite directions.

He concluded his talk with an indication of current research interest, noting especially topics associated with the changing ocean structure along a transmission path including mesoscale eddies of 2-300-km dimension, internal waves in the deep ocean, and fine structure. Finally, he stressed the importance of currents, long considered unimportant acoustically, emphasizing the significance of gradients rather than absolute velocity, e.g., in the sound-speed profile.

As noted above, the Cambridge meeting included a short underwater sound session which was very largely devoted to radiation topics. The first paper on this subject was by M.J. Earwicker (Admiralty Underwater Weapons Est., Portland, Dorset, UK) who discussed spatial sampling and measurement error criteria applicable to the determination of the radiated field from a vibrating structure as deduced from measurements on a nonplanar surface surrounding the structure. Dr. A. Freedman (Consultant, Weymouth, Dorset) then derived asymptotic expressions for the pulsed field of a baffled circular piston that can be used in the near and far fields down to pulse lengths of a few cycles. Dr. M.A. Swinbanks (Y-ARD Ltd., Glasgow, and now of Trinity College, Cambridge) followed with an elegant discussion of mechanisms of sound radiation from ribbed plate/frame structures, of the derivation of expressions for the summed output of transducer arrays positioned on the frames of periodically ribbed structures, and of a simple technique for monitoring radiation emitted by the structure based on measurements at the frames. All these topics tended to be closely related to the A.B. Wood Medal Address to be given the following

week in London by Prof. P.R. Stepanishen of the Univ. of Rhode Island, Kingston. Similarly, the Brekhovshikh address was much more closely related to the content of the London meeting than to the Cambridge one. However, protocol probably ruled otherwise, and certainly both addresses could not have been given in London, although that would have been an ideal solution to the underwater community.

We move onto London, where the meeting was in the able hands of Dr. R.H. Clarke of the Electrical Engineering Department of Imperial. The IOA's Underwater Acoustic Group has a reputation for successful meeting organization, and this one was no exception, being in its way as impressive as the earlier meeting held in Cambridge. Over 100 attended with about 1 in 3 from overseas (from the US, Canada, the FRG, Holland, Denmark, France, and Spain, with Brekhovskikh from the USSR). The 31 papers were admirably programmed for the maximum interaction into 6 sessions covering Systems; the Ocean; Shallow Water; Theories of Propagation, Fluctuations and Arrays; Underwater Noise; and Detection and Estimation. The papers offered a comprehensive review of the subject, and Clarke is to be congratulated on his success in bringing them together for it is unlikely that they could have been a chance collection. Here all attendees were exposed to the full spectrum of the subject as the papers were presented sequentially. Although attendance was large, it was not great enough to dampen lively interaction and discussion, and attendance and discussion remained at a remarkably high level to the end. Undoubtedly, because of a major effort on the part of Clarke, supported by the Underwater Acoustics Group, a preprinted book of extended summaries, including diagrams, of virtually all the contributions was available to the attendees on arrival and provided a valuable opportunity for preview and postmortem discussion and review. Copies of this collation are available from the Secretary, The Institute of Acoustics, 47 Belgrave Square, London SW1X 8QX at a nominal charge.

In view of the availability of this text for the specialist, we will restrict our discussion of the papers to a few representative ones and to some general remarks on some of the subject areas. The meeting opened with an excellent systems paper, "Reconciling the Acoustic Factors in the GLORIA Sonar Design," given by Dr. J.S.M. Rusby of the Institute of Oceanographic Sciences (IOS, Wormley, Surrey, UK). The current success of this system as GLORIA II has been outlined recently (*ESN* 31-11:443). Rusby traced the GLORIA development from desires in the early 60s to extend to the deep ocean the capabilities then available, by using high-frequency side-scan sonar, of obtaining sonographic recordings of the features of the sea bottom on the Continental Shelf. Outlining the various acoustic factors involved, he noted critical factors such as refraction that had dictated array depth, indicated areas in which it had been necessary to obtain additional research information such as on cavitation thresholds, and proceeded to discuss other factors where because of conflicting requirements it had been necessary to compromise, for example between acoustic power and array dimensions. This had led to the choice of 6.5 kHz as the operating frequency. A GLORIA I system was successfully used from 1969 to 1975 when many of its components were utilized in the much improved and more easily handled GLORIA II system.

The theory of fluctuations and the effect of ocean fluctuations on acoustic propagation received very special attention, reflecting in part Clarke's interests in and contributions to the field, particularly during the period he was at NATO's SACLANT ASW Research Centre in La Spezia. (R.H. Clarke, "Development of a Theoretical Model for Sound Propagation in a Deep, Variable Ocean," SACLANTCEN Report SR-8, Sept. 1974.) The various theories of fluctuation formulated in advanced and complicated extensions of work in the theoretical optics field were discussed in some depth. Work on characterizing acoustic fluctuations in terms of the A-Φ plane appears useful in parameterizing past experiments and very useful to the design of future ones. These theories have been reduced to equation form, and certain restricted solutions are available. While this work is advancing rapidly, solutions for real ocean conditions have yet to be calculated. Part of the work presented at the meeting in this field is already available in a new book by B.J. Uscinski (Univ. of Cambridge), *The Elements of Wave Propagation in Random Media* (McGraw-Hill, 1977), and in two books which are currently in the press. The first is by

S.M. Flatté (Univ. of Calif., Santa Cruz) and others, *Sound Transmission through a Fluctuating Ocean* (Cambridge Univ. Press, 1978), and the other is edited by John A. DeSanto (Naval Research Laboratory, Washington, DC), *Ocean Acoustics* (Topics in *Current Physics*, Vol. 7, Springer-Verlag Heidelberg, 1978). All three authors were among the contributors at the meeting.

Array design and the interaction of array elements also received considerable attention. A particularly interesting A.B. Wood address given by Stepanishen reviewed the theory of impulse response methods that are useful for evaluating the transient and harmonic radiation from or to acoustic arrays. The theory can account for self- and mutual-impedances in a simple way so that the effects of the interactions for wideband signals on array design can be evaluated. Stepanishen's review of a field to which he has contributed so much left no question as to the appropriateness of the IOA's award. The Wood Medal and Prize is awarded annually for distinguished work in the application of acoustics, preferably in connection with the sea, to a person who is preferably under 35 yrs of age. It is given in alternate years to a citizen of the UK and to a citizen of N. America (the USA or Canada).

A strong group of five papers on the experimental determination and theory of underwater noise was led by an excellent survey of recent work and knowledge of ambient noise in the 10-10,000-Hz range, given by Dr. W.A. Van Winkle [Naval Underwater Systems Center (NUSC) New London, CT]. Two sources predominate—surface agitation, which is highly wind dependent and arrives from the near vertical, and distant shipping with no wind dependence and which arrives on near horizontal paths. After a detailed and exacting review starting with earlier compilations, surveys, and analyses by Knudsen and Wenz and proceeding to the more recent studies of Vidale, A.D. Little, and others, Van Winkle discussed the reliability of prediction, and the importance of knowledge of noise characteristics, identified specific limitations in current knowledge, and indicated methods of overcoming them. Stressing the importance of background noise to system designers, he noted that after years of study there is still a serious lack of data for all geographic and weather conditions, and that understanding the subtleties of the subject becomes more important with the need for higher performance systems.

All in all, the Imperial College meeting with contributions from the UK, the US, FRG, and NATO's SACLANTCEN was highly successful, and a worthy companion to the Institute of Acoustics Spring Meeting held the previous week at Cambridge.

Since one of us is an Imperial graduate, we will not comment on the facilities made available at each venue—except to say that they were superlative. Standards achieved raised both meetings to the level of international events. To maintain the level achieved will call for very substantial effort on the part of future organizers of IOA activities. (J.P. Dugan and J.A. DeSanto, NRL, and A.W. Pryce, ONRL)

ENGINEERING

OPTICAL FIBERS SUPERSEDE MILLIMETRIC WAVEGUIDE

To prepare to meet the then rapidly growing demand for telephone channels when adequate optical-fiber technology was thought to be at least two decades off, the British Post Office ten years ago undertook the development of a millimetric waveguide system (*ESN* 31-1:25 and C-34-76). This system was to begin by linking Bristol with Reading through a 123-km buried pipe of 50-mm inside diameter and 80-GHz bandwidth capable of handling 500,000 two-way conversations at an installation cost of £7 million. Because of the rapid progress in the optical field and because of the slowdown in the growth of telephone traffic attributable to the 1973 oil crisis, plans for this link and, indeed, for any implementation of the waveguide technology in Britain have been scrapped. The standard coaxial-cable techniques will suffice until optical fibers can be brought into use several years hence.

An additional factor in the demise of the waveguide was the failure of the videotelephone (*ESN* 31-6:224) to attract any significant interest; because of its greater bandwidth requirements than the standard telephone, it could have represented a large demand for channel capac-

ity. Viewdata (*ESN* 31-2:72) requires only the normal voice bandwidth, and it (along with "System X," which represents a far-reaching modernization and digitalization of the UK telephone plant) may fully employ the 50 Post Office Research Centre (PORC) engineers who have been developing the waveguide system.

British Insulated Callender's Cables Ltd. (BICC), which was to produce the waveguide, will simply have to shut down the pilot plant it built, but the Marconi Company, which was to provide the transmission equipment, should be able to sell a good deal of the advanced components it has developed to the military for use in other sophisticated systems.

The series of London IEE Millimetric Waveguide Conferences in 1959, 1970, and 1976 had served to promote the idea of implementing this technology. Even though it became clear in the 1970s that this system could at best merely fill the gap until optical fibers (*ESN* 31-7:287 and C-12-77) are ready to begin taking over the job of wideband transmission, the PORC people involved in the waveguide project are quite disappointed, as it had been anticipated that sales abroad would provide a favorable foreign-exchange contribution for Britain. The lesson of the millimetric waveguide is that advanced development is still a gamble, and not everything that turns out to be possible will necessarily end up being implemented. The Post Office deserves credit for recognizing the unfavorable change in the economics of the project and for making the unpleasant but inevitable decision before finding itself committed to installing and maintaining a unique 123-km link whose high capacity no longer seems urgently needed.

With luck, the export losses suffered by this project will be more than made up by GEC, Plessey, and STC, which will supply equipment for the new approach to telephone switching, known as "System X." Its development cost is estimated at £100 million and its implementation, starting in 1981, will run to some ten times that much in the UK alone. It is being counted on to yield large foreign sales, but doubts have been raised as to whether it is not already somewhat out of date although intended to continue operating into the next century. In regard to Viewdata, however, Britain clearly holds a leading position and has already succeeded in selling its software to the West German Post Office (whose domain includes telephones) for some hundreds of thousands of dollars. (Nelson M. Blachman)

ELECTRICAL ENGINEERING IN PORTUGAL

Although it is not easy to find current addresses for Portugese departments of electrical engineering, a visit to Lisbon and Oporto revealed that there are six universities with undergraduate programs in this field as well as some graduate education and applied research, aided in a number of cases by cooperation with foreign organizations. The great majority of PhDs are earned abroad, thus serving to bring Portugal the latest knowledge despite her industries' not yet offering the stimulus found in more developed countries.

Electrical engineering is taught in Portugal principally at the University of Oporto's Faculty of Engineering on Rua dos Bragas and at the Technical University of Lisbon, whose campus is on Av. Rovisco Pais on the northeast side of the center of the city. A new university of Lisbon, the Universidade Nova, has recently been started on the northeast edge of the city, just east of the airport, on Quinta do Cabeço in Olivais. Electrical engineering is to be offered there as well as at the Universidade do Minho in Braga in northern Portugal and at the Universidade de Aveiro midway between Oporto and Coimbra. Finally, the University of Coimbra (founded in Lisbon in 1290) is setting up a program in engineering.

The Technical University of Lisbon (established in 1931) is a loose federation of schools of engineering and other specialties not included in the classically oriented University of Lisbon (reestablished in 1911). The latter, offering the bachelor's degree after three years of study and the licentiate after two or three additional years, has, for the most part, moved to the Cidade Universitaria (University City) on the north edge of Lisbon, not far west of the airport, but its Faculty of Science remains near the center of the city at 58 Rua da Escola Politécnica. (This Faculty was formerly called the Polytechnic School.)

At the Technical University, once a man succeeds in winning a teaching position through national competition,

he enters another competition to gain a part-time post at the Instituto Superior Técnico (IST), a large, separate organization located on the same campus. As a result there is a close tie between the two through their personnel as well as their proximity. While the Technical University has 7000 undergraduates who will receive their licentiates in engineering after a five-year course (involving laboratory work only in the last three years), doctorates are the domain of the Instituto Superior Técnico, and a portion of the IST's work is devoted to setting up postgraduate courses and writing textbooks for the 100 doctoral students. There is a desire among the staff to include industrial contracts as well as a research program supported by the government through the National Institute for Scientific Research (INIC), but industrial work is not yet permitted.

Among the electrical engineering groups at the Institute is the Centro de Análise e Processamento de Sinais (Center for the Analysis and Processing of Signals, CAPS). The chairman of its administrative committee is Prof. J.M. (Fonseca) Moura, who received his PhD from MIT. CAPS is organized along five "lines": (1) Signal analysis, (2) communication systems, (3) control systems, (4) instrumentation and electroacoustics, and (5) digital systems.

The electroacoustics group under Dr. H.F. (Onofre) Moreira has an anechoic chamber with 5 × 3 × 3-m working space for such things as microphone and loudspeaker testing. This group is collaborating with the Swedish Institute for the Handicapped and has sent a team of 6 people to Stockholm for 3 months to study audiology and to become acquainted with Swedish approaches to the education of deaf children so that Portugal can initiate such a program. As yet Portugal does not have any regular acoustics course, but the CAPS is developing a graduate course. Standards, training, and development work will be undertaken in audiometry and auditory prostheses.

The control-systems group consists of five or six people working under Moura on nonlinear and recursive linear filters, with a variety of applications such as Portugal's economy and the control of pollution in lakes and rivers as well as power-supply rectifier control and Kalman-Bucy filtering for passive Doppler navigation.

The signal-analysis group has two PhD's carrying on higher-order correlation analysis to obtain the bispectra and trispectra of seismic signals. They collaborate with the Civil Engineering Laboratory on soil mechanics and dams, since the level of the impounded water is a stochastic process. In addition, they are concerned with pattern recognition and with filters of various kinds—digital and analogue, infinite and finite impulse response. Prof. A. (Gomes) Cerveira, has recently left this group and the Technical University to join the Departmento de Engenharia Informática (Information Engineering) of the Universidade Nova, where he is now organizing undergraduate courses.

The digital group, headed by Dr. Guilherme Arroz, provides supporting services for CAPS and for the other research laboratories of the IST, such as the Centro de Física Atómica e Molecular (application of microprocessors), the Centro de Química Estructural (circuitry for positioning x-ray beams), the Centro de Química-Física, and the Centro de Física Molecular, as well as for outside research laboratories like the Laboratório de Psicologia Médica (tape recording of EEGs). The group has Hewlett-Packard and Wang minicomputers, and they are to have access to a larger CDC computer.

The communication-system group is primarily concerned with antennas and propagation, including underwater sound-propagation as well as Beverage, reactive-plane, and wideband VHF-UHF antennas. This group is also working on the equalization of channels for data transmission. Prof. Manuel J. (Petrony) Abreu Faro holds the chair of Telecommunication at the Technical University. His IST research involves radio propagation and wave generation, including the effect of rain on TV microwave transmission.

At the University of Oporto (founded in 1911) Prof. Auxiliar (Ass't Prof.) José (Diogo) Marques dos Santos is acting as head of the Electrical Engineering Department, having returned in 1977 from the University of Manchester's Institute of Science and Technology (UMIST), where he received his MSc and PhD. He looks forward to the election of a successor so that he can have time for research on control, automation, and microprocessors. He appears to be well qualified and intends to set up graduate courses in such areas in order to permit faculty

members to obtain doctorates, without which they can remain only 8 years. A doctorate is required for promotion to assistant professorship, and an aggregation examination is needed for associate and full professorship. In the past 15 years this EE Department has not granted a single doctorate, the degree being relatively rare in Portugal and not found among those employed in industry.

The Electrical Engineering Department has 90 faculty members and 1000 students, but the latter number is to be cut in half over the coming years, as quotas for admission have just been imposed (high-school graduation sufficed from 1972 to 1977 for admission), and EE will admit 100 out of the total of 350 for all branches of engineering. Only 280 passed the 1978 entrance examination, but EE had to turn some away, being oversubscribed. It seems to be a very fashionable field even though there aren't enough jobs for EE graduates. One-fifth get jobs in industry, and the rest have been obtaining secondary-school jobs teaching mathematics and science. But the recent huge expansion of high schools is completed, and this source of employment is gone.

The Department has several research projects funded by the government and hopes to get some industrial support, but industry likes to know in advance what it will get for its money, and so a different sort of arrangement may be required. In addition the Department has a European Economic Community research project concerning the propagation of microwaves through rain, but the faculty member in charge of this project is at Bradford University (UK) working on his PhD. The chair of telecommunication is held by Francisco (Velez) Grilo, but he was absent during my visit on account of the 3-day holiday for the beginning of Lent (Mon-Wed).

Portugal's low level of industrialization deprives the country of some of the motivation and resources needed for the development of a flourishing program of research in electrical engineering. Nonetheless, she is keeping up with progress in this area and can be expected to do more in the future as her graduate education grows. In the meantime, Portugal remains a very attractive country, with good, inexpensive facilities for visitors, and she deserves to receive more contacts from abroad.

In closing it may be useful to point out that in Portugal, unlike Spain, the mother's family name (around which I have put parentheses) precedes the father's. The latter may in fact consist of more than one word, perhaps introduced by *de*, which is generally omitted. While the father's family name is the official one, the mother's is used in practice if the father's is too common.
(Nelson M. Blachman)

HOVERCRAFT STRETCH

June sees the introduction into commercial service of the world's largest hovercraft THE PRINCESS ANNE. This British Rail Seaspeed is an SN-4 hovercraft which has been lengthened and refitted by the British Hovercraft Corporation (BHC) of East Cowes, the Isle of Wight to carry 418 passengers and 60 cars as compared with the standard 254 passengers and 30 cars. It is now the jumbo jet of the hovercraft fleet.

Seaspeed and Hoverlloyd operate a combined total of six commercial SN-4 hovercrafts across the English Channel. Seaspeed routes from Dover to Boulogne and Calais are serviced by THE PRINCESS ANNE and THE PRINCESS MARGARET while Hoverlloyd runs four similar vessels between Ramsgate and Calais. Between them they account for a 30% share of the cross-channel ferry traffic. In 1976, Seaspeed service alone conveyed 800,000 passengers and over 100,000 vehicles. Hoverlloyd service has grown to over 200,000 cars and 1.1 million people, and they expect to make a profit of over $2 million this year. The cross-channel service is put to its limit during the summer tourist season. Hence the excitement at the launching of the stretched THE PRINCESS ANNE.

Known as the Super 4, THE PRINCESS ANNE is capable of 65 knots in service. The deadweight tonnage of the craft has been increased from 200 tons to 280 tons, making it 40 tons heavier than the new French Hovercraft Sedam N-500. This increase was accomplished by cutting the vessel in half and inserting a new 55-ft center section lengthening it to 186 ft and giving a near optimum "length-to-beam ratio" for the Channel of 2.25. This, combined with a new skirt design, will increase ride comfort and allow operation in higher sea states. With 12 ft of

low-pressure air separating the hull from the water, the designers predict that THE PRINCESS ANNE should be able to operate comfortably in a force-nine gale with the wind gusting to 40 knots, compared with a 30-knot limitation before stretching.

The power of each of the four engines has been increased from 3,400 hp to 3,800 hp per engine, resulting in a 1,600 hp increase overall. New large paddle-bladed propellers of 21-ft diameter have been incorporated. These changes have reduced the horsepower per ton of all up-weight from 68 to 50 which, together with an improvement in engine fuel consumption, will result in a reduction in direct operating cost of 30% per ton/mile, with a 70% increase in payload for a 10% increase in power.

THE PRINCESS ANNE Super 4 has been designed specifically to improve the economics of hovercraft operations. The extra capacity coming from the new 55-ft center section raises the payload by 70%. The improvement in load carrying capability is accomplished with only a modest 10% increase in power, making operation most economical.

The French have introduced a competitive vessel, the Sedam N-500 that is fitted for 60 cars and 400 people. She is now conducting trials near Boulogne and is scheduled to enter service soon. Unfortunately, however the French have had a string of bad luck with this development. Their chief designer died early on, the first Sedam 500 was destroyed by fire in the shipyard last year after a welder's torch ignited her rubber skirt, and now the latest N-500 has had her bow structure damaged while on trials in the Channel, and there is a suggestion of handling problems also.

The Super 4 is in the limelight. The payload increase and improved economics add up to an extremely competitive craft. Conventional ferry operators have taken notice of the BHC Super 4 craft. Hovercraft reliability has increased dramatically since service started ten years ago, and THE PRINCESS ANNE lowers the load factor for profitable operation. A hull-borne ferry needs only carry a load factor of 25-30% to make money. The SNR-4 needed to have a load factor of around 60-65%. The stretched Super 4 needs only a load factor from 40-45%, closely competitive with a hull-borne craft.

THE PRINCESS ANNE crosses the 23 miles of Channel, Dover to Calais, in a scheduled flight time of 30 minutes, while the hull-borne ferry requires one hour and 45 minute crossing time. Seaspeed already claims a winner as they anxiously face the increased traffic of the summer tourist season. (C. Joseph Martin, Liaison Technologist from David W. Taylor Naval Ship Research and Development Center, Bethesda, MD)

GENERAL

NATO SCIENCE COMMITTEE ANNIVERSARY

The Science Committee of the North Atlantic Treaty Organization is 20 years old and celebrated this event by holding a large conference in Brussels. There were over 300 participants during the course of the meeting held at the Palais d'Egmont from 11-13 April. The audience comprised official delegations from 15 member nations plus other scientists, administrators, and individuals who at one time or another had direct or official relationships with the NATO Science Committee. Professor M. N. Ozdas, NATO Assistant Secretary General for Scientific and Environmental Affairs, served as Chairman of the Conference. At the opening and closing sessions, Dr. J.M.A.H. Luns, NATO Secretary General, presided.

It is instructive to know the primary objective of the NATO Science Committee; namely, to strengthen education and research in the sciences and technology through increased international cooperation between scientists and engineers in the Alliance countries. Over the years, almost all fields of science have received some support to foster the exchange of knowledge, provide opportunities for advanced instruction, and engage in multinational collaborative research.

The 1978 budget for the NATO Science Committee programs is approximately $10,000,000. This sum is allocated in the following ways: 55% of the budget is awarded for science fellowships, and these enable scientists to be exchanged between the Alliance nations. About 750 fellowships are awarded each year. In addition, there is a Senior Scientists program that is rather small but is administered at NATO. This provides opportunities for outstanding scientists in one country to develop research programs in other NATO countries.

The Advanced Study Institutes take about 21% of the budget. This program is geared mainly for young people in the early stages of their careers to get together and receive instruction from leading and prominent workers in a discipline, usually in somewhat stimulating and beautiful surroundings. These Institutes are ordinarily for two-week periods, and in general they cover a wide spectrum of disciplines. The Proceedings are then published in volumes that give overviews of fields in which there is a rapid scientific development. Over the years, some 600 texts have been published. In 1978, approximately 60 Advanced Study Institutes are on the agenda, and these are to be held in the various member countries.

About 14% of the budget goes to the Research Grants Program to support teams of research workers in which particular emphasis is placed on international contact between the scientists. It is especially developed for projects that do not fit easily into an individual country's research and development program. The remainder of the budget (about 10%) goes for program planning and for special program panels. At present there are 6 program areas: eco-sciences, marine sciences, air-sea interaction, systems science, human factors, and materials science.

The NATO science programs are singularly free from any interaction with the military in each of the NATO countries. Article 2 of the North Atlantic Treaty provided a basis for non-military cooperation in NATO. There is the belief, already substantiated in national programs, that enhancing science and technology in each of the member nations increases the well-being of each of the nations and in this way contributes to its strength, military, economic, and otherwise.

Over the 20 years, the NATO Science Committee has demonstrated that its model for international collaborative research and education works well. One important reason is that very distinguished scientists make up the Committee. Since its inception, Professor I. I. Rabi, Nobel Laureate in Physics, and Professor William Nierenberg, Director of the Scripps Institution of Oceanography in La Jolla, have been American representatives to the Committee and at one point Nierenberg served as Assistant Secretary General for Science in NATO.

The other member nations also have very distinguished scientists associated with the Committee; for example at the opening session both Rabi and Professor L. Neel of France, Nobel Laureate in Physics, gave their reflections on the NATO science program. One would be remiss in not noting that the head of the American delegation to the conference was Dr. Frank Press, Science Advisor to President Carter, and Director of the Office of Science and Technology Policy. This was emulated in the other delegations.

The conference itself was quite interesting in that the sessions reflected the emphasis today on systems analysis studies of societal problems. Sessions lasted half a day over a 2½-day period, and only in the first session of the first day was attention given to individual scientific disciplines. Papers had been prepared by leading scientists reviewing developments over the last 20 years in mathematics, astrophysics, materials science, environmental sciences, molecular biology, whole organism biology, systems science, and electronics. These papers were not presented except as written reports. They were then reviewed, at best in a general way, by R. J. Maddox, formerly editor of *Nature*, and now Director of the Nuffield Research Foundation. Following this review, each of the authors was given an opportunity to reply.

All the other sessions were given over to what might be described as systems analysis studies of such topics as energy, analysis and decision-making, population and education, economic problems of advanced and developing countries, technology and standard of living, impact on society of information technology, science technology and international relations, etc. The Proceedings will be published in two volumes by the Oxford University Press.

The emphasis on societal issues suggested the question as to whether science, as interpreted by the NATO Science Committee, should now be extended to include the social sciences. This would be a shift from what has been the tradition, therefore questions of how to organize such a program, assuming it should be done, obviously have to be considered. It will be of interest to note, in the future, how the NATO Science Committee will include social science research in its programs.
(Herbert Solomon)

BRITISH POLYTECHNICS—LOOKING FOR A PLACE IN THE SUN

In the hierarchy of British higher education there are, first of all, the universities which are empowered to grant degrees and whose activities are strongly research oriented. Their support comes largely through the University Grants Committee which allocates the funding appropriated by the central government. Additional funding for specific scientific research projects comes normally from the Scientific Research Council (SRC). It is these university institutions of education with which most of us are familiar.

Back in 1966 the UK government issued a White Paper entitled "A Plan for Polytechnics and other Colleges." From this founding document the current concept and many of the present Polytechnics originated. Polytechnics had existed for many years before 1966 and had played a major role in higher education. Together with a wide variety of other educational institutions including training, technical, and art colleges, they met a range of educational requirements often associated with industry, trade, or vocations, and local community or social needs. Frequently, though not exclusively supported at the local government level, these institutions offered a wide variety of courses, usually leading as a result of full- or part-time study to the award of specialized diplomas associated with various trades and vocations. Many also served as an alternative route for acquisition of the educational base needed for a first degree. The student registered as an external student at one of a small number of British universities and then met that university's external examinations requirements. Higher degrees could also be obtained via this route. This external degree system was particularly highly developed at London University, whose external examinations were utilized worldwide, especially in the Commonwealth—providing a universal standard. With the rapid expansion of the UK university base in the post 1939-45 war era, certain institutions provided kernels around which new universities developed, including a number that first became Colleges of Advanced Technology and then moved on to University status (See *ESN* 16-8:152 "The Cat's at the Door," Medwin, 1962 and *ESN* 20-4:41 "Some Information Concerning Britain's Universities," B. Epstein and S.Y. Tyree, 1966).

The 1966 White Paper recognized the important role of these institutions, the part they played, and the growing part they could play in meeting the increasing demand for higher education. Situated in the local communities, by which they were largely supported and responding to community needs, they offered a valuable avenue for higher education at the local level paralleling that offered through the expanding university system. The plan unveiled in the White Paper was to pull together selected institutions in a given area to form parts of an area-based Polytechnic. The larger size of the Polytechnic and its breadth of function would give it greater strength, more flexibility, a more prominent role in the community, and a larger sense of being responsible for meeting the educational needs of the community.

The role of the Polytechnics, as given in the White Paper, is a broad one:

> "The object of developing a new pattern now is to see that the rapidly mounting demand for higher education within the system of Further Education is met in such a way as to make the best possible use of these (existing) resources without prejudicing opportunities for the tens of thousands of less advanced students who wish to take courses at intermediate and lower levels. The Government believe that this can best be done by concentrating full-time courses of higher education as far as practicable in a limited number of strong centers. The Government believe it to be of the utmost importance that the leading Colleges concerned with higher education should be comprehensive in the sense that they plan their provision of courses to meet the needs of students in all three categories (full-time degrees, below degree, and part-time). The comprehensive range and character of the work of these institutions will broadly distinguish them from other kinds of higher education institution. As mixed communities of full-time and part-time teachers and students, they will as a whole have closer and more direct links with industry, business and the professions."

In October 1977 a committee reporting on the Polytechnics to the Science Research Council noted,

> "As can be envisaged from this (White Paper) description, the polytechnics' function overlaps greatly with that of the universities. Although there are obvious differences in their backgrounds, academic emphasis and, especially, administrative and financial procedures, there is little that polytechnics do at undergraduate and graduate levels that universities could not also do."

So how are the Polytechnics working out? There are 36 UK polytechnics, if 5 Scottish and one Northern Ireland institutions are included. The smallest polytechnic has about 2000 full-time equivalent students and the largest about 6000. Altogether they consist of about 20,000 full-time equivalent staff and 130,000 full-time equivalent students, over a half of the students being involved in degree courses at undergraduate and postgraduate levels. In 1975 about 11,000 first and 600 higher degrees were awarded. In science and engineering, the numbers of full-time equivalent undergraduate and postgraduate students were about 26,000 with over 5,000 first and 500 higher degrees being awarded; these numbers are roughly one-fifth of the total students in universities, one-fifth of the first degrees, but less than one-tenth of the higher degrees awarded by the universities. It seems clear that the "Polys" are making a very substantial contribution to British education.

No one in the UK, however, confuses the Polytechnics with the universities. A degree from a university is considered much more prestigious than a polytechnic one. (This was always the case with the external university degree system, but it was then clearly recognized that the acquisition of such a degree called for very considerable tenacity and effort on the part of external degree candidates). Universities are independently able to grant degrees; Polys are not. Their students must now satisfy a central body (the Council for National Academic Awards, CNAA) that they qualify. The Polys are largely composed of institutions with a heavy emphasis on teaching and little or no history of research. Polys cater to part-time students and see to it that vocational work and nondegree programs are not slighted. Polys are funded by the Local Education Authority (LEA) of the area in which they exist. These funds may be from the central government in part, but the LEA has a strong role in obtaining and spending them. Money for teaching equipment may be included, but there is none for research facilities. Any item of equipment costing more than £2,500 (about $5,000) has to be approved by the head of the Department of Education and Science (DES).

To start a new advance course, a Poly must obtain internal approval first. Then the LEA has to approve. The DES must approve courses of more than 4 weeks in length as their concern is a national need for courses of the type being proposed. Then the course must be validated by the CNAA, who uses committees of independent experts from polytechnics, universities, industry, and the professions to ensure that the course meets university standards. They assess the course syllabus, the staff, and the teaching and research facilities. The whole procedure from course initiation to final approval may take from 18 months to 2 years and may require resubmission every five years.

Many Polys are still relatively young, and their transition to a new role is still underway. Many of the staff have only a teaching background and have been carried over from earlier days. So are the buildings which are often quite far apart. Government funding has not allowed for the creation of new well-integrated campuses. As a result, progress toward the Polytechnic goal faces uncommonly trying difficulties. Nowhere is this more apparent than in their efforts in research. The CNAA considers on-going research to be necessary for colleges that hope to offer degrees, and it tries to influence colleges to develop research activities, but at present only about 5% of the total polytechnic expenditure is thought to go into research in science and technology. The SRC evaluation committee tries to encourage research and development programs that are multidisciplinary and that couple with industry and government. Problems are the lack of money and the inexperience of many of the newer research-minded staff. The SRC funding committees feel that a demonstrated research capability

of university standards is a prerequisite to funding, but without financial support no such research capability can be developed!

We have emphasized some of the difficulties facing the Polys because we are impressed with what has been accomplished in spite of the hazards, in the short period of 10 to 12 years associated with the new look. Currently their research involvement varies widely; but one senses that with their feet in the community, the Polys' contact with local industry is strong, and it is in this arena that many see their research potential. If, of course, the research activity does grow substantially and this may be aided by the concern in the UK that research should be more application and industry oriented, it will be increasingly difficult to identify the differences in the roles of university and polytechnic.

One development along the lines of community-related research began early this year involving the North East London Polytechnic and workers from the Lucas Aerospace Company. Over the last eight years the work force at Lucas has dropped from 18,000 to 12,000 and there have been broad hints from management that the number is still 4,000 too large. Alarmed by this trend the Lucas workers set up a Shop Stewards Combine Committee to try to increase the range and vitality of Lucas products by introducing "socially useful" items. A large number of ideas were proposed by the staff, but the Company management did not feel that it could support any of them.

It was at this point that the Combine Committee turned to North-East London Polytechnic. After some discussion the Polytechnic decided that this was an opportunity to make the school really relevant to its community. There evolved a "Centre for Alternative Industrial and Technological Systems" involving both the Combine Committee and the Polytechnic staff. It has a steering committee of academics and industrial workers, encouragement from local trades councils, and financial support from a charitable foundation. This funding has allowed the Centre to hire a full-time coordinator, Mr. M. George.

The Centre's first project is an attempt to develop a portable kidney dialysis machine. Lucas makes a non-portable machine designed for hospitals. The market for this is limited, however, since the National Health Service has concluded that it cannot afford to purchase more machines, although a few may be included in the latest national budget.

George and the Centre believe that the development of a simple portable machine would allow new flexibility in treatment of patients. Letting a patient have a machine in his home and training him to use it himself, would permit his continuing to work normally. Under the present system the trips to the hospital and long waits for treatment make it impossible for a patient to carry on steady work. His support then becomes a burden on the government. It is argued that the money saved by keeping people on the job would more than pay for the machines. The Centre is working on a number of dimensions of this problem. It wants to design a portable and reliable machine with modern electronic controls, it wants to convince the National Health Service and the Government that such a development makes financial and humanitarian sense, and it wants to develop a product that Lucas feels it has the experience and talent to market commercially.

Other areas that the Centre is considering are electronically guided transport for rail systems, a heat pump powered by natural gas instead of electricity, a road vehicle running on batteries powered by a low-fuel internal combustion engine working at constant speed, and the transformation of old newspapers into fire-resistant thermal insulation for houses. In each of these cases one can imagine that the cost for commercial development might be heavy and a company might well feel that the risk is too great. A consortium of volunteer faculty members, students, and industrial engineers, with a minimum of support, just might pull off a few of these developments. A single success could be most beneficial.

Whatever the outcome, the fact that such an enterprise is being attempted is itself significant. If polytechnics are to couple with their communities, with industry and government, then North-East London Polytechnic is doing its best to explore a way in which that mission may be accomplished. There are other ways, of course. Certainly at UK scientific and technical meetings the Polys are now often in evidence both in contribution and attendance.

The growing social ramifications of technology suggest natural Polytechnic interest in some fields not only for training but also in terms of applied research effort aimed at the solution of a wide range of problems of immediate local community interest.
(A.W. Pryce and Clifford C. Klick)

MATERIAL SCIENCES

CONTROLLED RELEASE GLASS—A NEW CONCEPT FOR AN OLD MATERIAL

Glass is a material that goes back very far in human history; the *Britannica* says that the earliest examples of wholly glass objects are Egyptian and are dated at 2500 B.C. Over the succeeding years the principal uses of glass fall into two broad categories. One is as a container material: medicine bottles, cathode ray tubes, cathedral windows, and automobile windshields all protect valuables from a harsh environment. The other use of glass is as an optical element: Eyeglasses, microscopes, chandeliers, and more recently, laser glasses and high-transmission glass fibers for optical communication. A commonly desired property of glass for all of these applications is that it be strong enough and stable enough to resist mechanical stress, attack by water, and variations in temperature. Many glass compositions are not used because they fail to meet some of these requirements.

C.F. Drake and M. Graham [Standard Telecommunication Laboratories (STL), Harlow, Essex, England—an ITT laboratory] have been exploring a somewhat revolutionary reversal in thinking by looking for applications of glass in which a controlled solubility in water would be an asset. They call this Controlled Release Glass (CRG). Glass compositions based on phosphates and borates are often water soluble, and the degree of solubility can be varied by changing the glass composition. Also, glasses can be used to incorporate large concentrations of inorganic ions. So, the kind of application one would seek is that in which a slow release of such ions would be advantageous. Consider boron for instance. It has long been established that boron is important as a trace element for higher plants, but above a critical concentration it becomes toxic to them. By selecting a suitable release rate of the borate ion into the soil water, a slightly toxic concentration of borate in a well-defined area can be maintained for a long period and plant growth prevented. Such a non-selective herbicide might be useful for pathways, gravel pavements, forestry firebreaks, railway lines, and similar applications. Early tests on this application showed that protection was achieved for periods of as long as 30 weeks and that there was very little spread of the herbicide into nearby untreated areas.

It has also been suggested that CRGs could be used to supply fertilizer in small concentrations for long periods of time. Fertilizers ordinarily contain nitrogen, phosphorus, and potassium in nearly equal concentrations. It is easy to incorporate phosphorus and potassium in glass, but nitrogen compounds volatilize at the temperatures needed to prepare glasses thus making their incorporation difficult. Even so, some interest has been shown by forestry groups in England in some special applications for seedling growth.

Pesticides are another possibility for the application of CRG with copper ions as the active agent. A concentration of only 1 ppm of copper in water kills a number of common pests. Work is beginning in cooperation with the Department of Tropical Medicine, Liverpool Univ. to study effects on mosquito larvae with applications to the control of malaria and yellow fever. They are also looking into the use of these glasses to help eradicate the water snail that is part of the cycle involved in the tropical debilitating disease *bilharzia* found in Africa. It may be possible to do on-site work in Nigeria within a year to test some of these applications in the field.

There are numerous other applications that have been thought of, and on which some early work has been done. These include putting copper containing glasses into anti-fouling paints; copper is known to inhibit barnacle formation. Zinc phosphates and chromates in paints could aid in reducing corrosion. Veterinary research groups are considering animal implants to release copper for animals raised on copper deficient soil. The possibility of a slowly cross-linking

cement to replace plaster of Paris for medical purposes has been suggested using the glass to release the cross-linking ions. Even dental uses have been considered: A dental filling that released fluorine to inhibit further decay might be possible.

Much of this work is in a very early stage. Furthermore, almost all of the applications are outside the expertise of the inventors and of STL. As a result, cooperative ventures are required between STL who supplies the glass technology, and other groups evaluating the application feasibility. Only a single paper has so far been written on the new glass concept; it concentrates on herbicides and fungicides.

In general, the advantages of these glasses are that they involve low technology production, common materials, and, as a result, low cost. They are not biodegradable. In some cases they would represent a lower environmental hazard than competing treatments. When depleted, the glass leaves no residue. Physically, the glass can be prepared as powders, rods or fibers, woven mats, or foamed masses that float on water. The disadvantage is that it is not possible to incorporate organic materials in the glass since most of these decompose at the glass melting temperature.

As with most bright new developments in their early stages, the eventual areas of application of CRG are not clear. There are so many possibilities, however, it seems very likely that we shall be hearing of this new kind of application of glass for a long time to come. (Clifford C. Klick)

ONRL REPORTS

See the back of this issue for the abstracts of current reports.

MASS EDUCATION WITH STYLE

One of the more serious of the many problems facing universities all over the world is the changing age and socio-economic groups from which student populations in sufficient numbers can be drawn. No longer is there an overabundance of bright, anxious (and usually middle-class) 18 year olds queuing at admissions offices, and demographic projections indicate it will get worse before it gets better, particularly in the US. Faced with the necessity of running the physical plant efficiently (and also of finding ways to keep us old professors occupied) many schools are making serious attempts to attract a broader spectrum of students, be it older people, those employed in full-time jobs, or those with backgrounds that traditionally precluded them from going on to higher education. To affect such changes means fundamental adjustments in course material, teaching hours and loads, etc., and it remains to be seen how seriously traditional universities will undertake these endeavors.

However, it may well be a moot point whether they do or not, particularly in the UK, where they will face a formidable competitor, the Open University (OU), whose primary aim is to cater to the educational needs of the atypical student. (Several *ESN* articles from October 1969 (23-10:276) to February 1973 (27-2:42) have described the early days of the OU.) Judging from its growth since it began offering courses in Jan. 1971, it is accomplishing this goal very well indeed. OU now has over 60,000 students throughout the UK and has awarded over 21,000 degrees.

The history and development of the Open University provides an interesting view into how politicians and bureaucrats can respond positively and reasonably quickly to a demonstrated educational need, particularly when it is a pet project of a soon-to-be prime minister, Harold Wilson. Drawing on prior efforts of the Department of Education and Science and the British Broadcasting Council, he proposed in 1963 the formation of a University of the Air, a home-study university using the broadcast media as an integral part of the teaching method. Potential students were to be drawn from the very large number of school leavers who did not immediately go on to higher education, but who instead entered the job market or worse yet went "on the

dole." After the expected and inevitable number of committees and Green Papers (study documents), a Royal Charter established the Open University in 1969 as "an independent and autonomous institution" authorized to confer degrees (the equivalent of accreditation in US universities).

The operating-structure of the Open University is fairly straightforward. There are no admission requirements as such, and entrance is on a first-come-first-serve basis. Students are older than found in more traditional universities, and most are engaged in full-time employment or in raising a family while they study. Teaching methods for most courses involve a combination of correspondence texts, television and radio broadcasts, other audio-visual techniques, specially designed home study kits for practical experiments particularly in science and technology courses, and the use of individualized tutoring at local study centers or at residential summer schools. Since the students are located all over the UK, serving abroad in the army or, on occasion, foreigners close enough to Britain to pick up the radio and TV broadcasts, the logistics of running courses is a quite formidable task. Most of the classes are organized and managed by a team of faculty aided by assistants and a country-wide network of tutors, the last often moonlighting from daytime jobs as lecturers in local Polytechnics.

The courses of study encompass those for self-contained study, as well as for attainment of recognized undergraduate and postgraduate degrees. Over 100 degree credit courses are offered by six faculties: Arts, Mathematics, Science, Social Sciences, Technology, and Educational Studies. There are in addition 34 full-length non-degree self-contained courses designed for those students who may wish to extend their knowledge in their own field or acquire knowledge of a new one. An important feature is that some of these can be subsequently used for credit if the student decides to pursue a degree program.

For those pursuing the BA and BA (honours) degrees, there is considerable latitude in structuring a program of study. However, with prerequisites, and the well-known subtle persuasion of advisors, students desiring a specific degree often take quite similar programs incorporating the most important (and usually the most demanding) courses in their specialty area. In addition, all but the very qualified are encouraged to take a first-level foundation course, a broadly-based introductory course in a particular discipline that assumes no prior knowledge of the subject. The course is clearly intended to be remedial in nature. Basic courses are followed by second-, third- and fourth-level courses. One credit is awarded for successful completion of a full year-long course, taken from January to November, with an estimated weekly workload of 10 to 15 hours; a maximum of two such courses can be taken in a year. To obtain an ordinary BA degree, 6 credits are needed and for an honors degree 8 credits. While many students do complete their degree in the minimum 3 or 4 years, incomplete statistics, owing to the short life span of the University to date, suggests that many of those enrolled will be much more patient in obtaining a degree, indicative of the tradeoffs that adults must make between education, working, and family life.

To illustrate in more detail the flavor of the courses in a technical discipline, I want to discuss the materials program and to present some of the innovative teaching techniques that have been developed by a staff faced with the problem of presenting complex concepts and analyses to a diverse group of students. In many respects teaching materials-based courses presents quite unique difficulties (remarkably those who have to teach almost any course invariably make the same claim) since the field lacks the more structured limits of subjects like mechanical and electrical engineering, as its origins stem from a combination of physics, chemistry, mechanics, chemical engineering, and the like. In fact, a metallurgy or materials program was for many years often a section of a mechanical or chemical engineering department.

The approach at the Open University by faculty members like Nick Reid and Charles Newey has been to present such broad-based material in a way as to make it as interesting and palatable as possible. Their basic materials second-level course, "An Introduction to Materials," starts out in a fashion similar to most courses of this type. Assuming that the student has been exposed, most likely through a foundation course, to the basics of mechanics, atomic structure, the periodic table, and wave motion, the initial part of the course is devoted to analyzing

the structure of materials in terms of electrons, atoms, molecules, and microstructure, and then relating these microscopic effects to macroscopic properties, such as mechanical, electrical, and thermal behavior. Students are aided by weekly radio and television programs, and several experimental kits containing, in part, a reflection microscope, a creep tester, a hardness tester, a multimeter, a solar cell, and a metallographic kit with specimens. With these kits, students are expected to undertake and complete a series of experiments described in a Home Experiment Book.

The second half of the course, and the more innovative part, consists of a series of six case studies to illustrate how the science of materials can be applied in real situations and to show the development of materials technology. The cases currently used are: 1) an examination of the relative advantages of glass and plastic milk bottles; 2) the relative merits of solid-state and thermal conversion devices for the large scale utilization of solar power; 3) construction of car bodies and possible materials substitutes for steel; 4) the selection of an iron-silicon alloy for the core of a large power transformer; 5) materials selection procedures for the skin of the supersonic aircraft Concorde; and 6) devising a systematic, scientific research program to develop porcelain, whose actual development came about by a slow trial-and-error procedure. As with all aspects of the course, the student is directed (but it is claimed not led) by well-written, detailed, study manuals, and periodically tested by homework assignments. The course ends with a final written exam.

A follow-up third-level course, "Materials Under Stress," continues this case history approach, with the more focused topic of how materials in the form of structural components or machines respond to loading and to how an understanding of material and design requirements can reduce the possibility of failure under load. Seven quite detailed case histories, involving in some instances actual service failures, have been developed to show the students how failure of components is integrally related to the engineering activities of design, materials selection, production, maintenance, and inspection. The general unit topics that incorporate the case histories are: Learning from failure; designing against failure; the stability of cracks; the Markham Colliery disaster in which a pit cage failed to slow approaching the bottom of a mine shaft, killing 18 miners; stress corrosion; designing with plastics; and survival at high temperature. Again the written material is excellent; case histories are carefully documented, with considerable background information, as needed. The student is exposed to a variety of factors, including cost tradeoffs, a factor which may have directly or indirectly led to the failure. Home experiment kits are used in this course also, and include numerous stereo slides and surface replicas of a wide variety of fractures in steels, aluminum, brass, polymethyl-methacrylate, wood, and carbon-fiber-reinforced plastic, as well as a polariscope for photoelastic stress analysis of a plastic specimen, and equipment to perform an *in situ* stress corrosion test. At the end of the course each student is given an individual project, either a failure analysis or a design task. He receives only a statement of the problem and is asked to make use of previously learned skills and techniques to obtain a solution.

The effort expended by the course team is impressive, to say the least, and the courses are continually monitored and modified, as needed. Those of the team I talked with were very sensitive to the dangers of producing rote correspondence courses, where memorization alone can suffice. In order for the courses and the program to receive wide academic acceptance, the stigma of a correspondence school (instant education as promised by a myriad of matchbook cover advertisements) must clearly be avoided. As proof of their success in doing this, they cite growing recognition from their peers. For example, traditional universities like London, Sussex and Kent have admitted Open University students using transfer courses either to satisfy entry requirements or for advanced credit. More importantly perhaps, Oxford has accepted Open University graduates to study for higher degrees. My impression, from only a brief exposure, is that the courses are quite rigorous with the maturity of the older student counteracting the homogeneous teaching methodology so common to and, in my opinion, the major problem of self-paced learning courses.

A further measure of the success of this program is its successful marketing to other countries. Foreign language editions of some of the texts are available in Spanish, Dutch, Danish, and Italian. There is a considerable market for these, as well as for audio tapes of radio broadcasts and 16-mm sound films of the BBC television programs. In addition, the techniques and systems developed are being used to help create similar teaching-at-a-distance institutions in Iran, Israel, Pakistan, and very likely soon in the US.

The critical ingredient to the success of this enterprise is the faculty and the support staff. Almost all of the faculty have "sacrificed" years of research and have instead committed themselves to the complex and time-consuming task of course development, monitoring, and instruction. This can be a dangerous path particularly for younger faculty, who without adequate scientific credentials can and in fact have found their mobility adversely affected. These problems seem to have been recognized by the University and increasing emphases (and funds) have been promised to provide a more attractive research atmosphere. The necessary ingredient, a graduate program, is being continually expanded both at the central University complex located at Milton Keynes, Bucks, and at their Oxford Research Unit, a complex that has been specializing in the study of irreversible processes, biophysics, design, properties of polymers, and blood sugar regulation, but is considering moving into other, perhaps more fundable areas. Outside funding has been adequate in some areas but nonexistent in others, an imbalance that it is hoped will be redressed in the near future. (For those readers less familiar than I with the Queen's English, this latter phrase when translated into American reads "hope springs eternal").

All in all, the Open University is an impressive entity, conceived to solve a defined need, well organized, and offering a quality program. I predict a growth of such programs, perhaps not solely designed to compete academically with traditional universities, but instead to provide an alternative educational experience to a broad and largely untapped group of potential students. (I.M. Bernstein)

MATHEMATICAL SCIENCES

STATISTICS AND PROBABILITY IN GREECE

Statistics and probability are rather new subjects in the curricula of Greek universities. This is so even though the word "stochastic" employed to specify randomness is borrowed from the Greek language. The roots of that word in ancient Greek describe the variation of points of impact around the center of a target when one is aiming at the center.

At present there are chairs of statistics in the University of Athens, the National Technical Polytechnic of Athens, the University of Thessaloniki, the University of Patras, and the University of Ioannina. In the new University of Thrace (Xanthi) statistics is offered, but a chair has not yet been established.

The occupants of these chairs have all received their doctorates in the United States or the United Kingdom. Professor Theophilos Cacoullos of the University of Athens received his PhD at Columbia University about 20 years ago. In Thessaloniki, we find Professor S. Kounias who was trained at the University of Manchester. The chair at the National Technical Polytechnic of Athens has been awarded to Professor C. Tsokos, who is not yet in residence, and who was trained at the University of Connecticut. Professor P. Papaioannou occupies the chair at the University of Ioannina, and he received his doctorate from Iowa State. At the University of Patras, the chair is held by Professor G. Roussas, who was trained at the University of California, Berkeley.

Cacoullos began his present assignment at the University of Athens about ten years ago, after teaching at New York University and Minnesota. The others have come to their chairs much more recently, usually after teaching in the US or Canada. In 1972, Cacoullos organized a NATO Advanced Seminar on Multivariate Analysis held in Athens, and a volume containing the Proceedings of that Seminar has been published.

There is some research going on by professors of statistics. Cacoullos is working on recurrence relations, for example, Stirling numbers of the first and second kind, and bell polynomials and

their relationship to discrete distributions. Kounias is working on design of experiments in the formal sense of Kiefer at Cornell. Roussas is working on probability theory and reliability theory, and Tsokos works on reliability theory.

There does not seem to be much, if any, interaction between professors of statistics in the universities and government agencies and industry. Of course, it is only very recently that statistics was regarded as a separate discipline, and in time applications of statistics and probability in agriculture, public health, forestry, and manufacturing may come to the fore as happened in the US and other countries.

It may be instructive to look at the actual curriculum in statistics in Greek universities. Students enter university from high school with a fixed major. The major depends on the candidate's statement of preferences and his performance in the university entrance exams, which are the same for all universities. Courses are distributed by major and by school year. In mathematics and the sciences there are four years of courses leading to a diploma, but attaining the diploma takes five years on the average. A typical program for a year consists of five courses for which two semester courses equal a one-year course. Usually, four of the five are required, that is, they are fixed courses taken by all students of the same major. One and sometimes two electives may be taken. It is interesting that mathematical statistics courses are obligatory for mathematics majors in all universities and in Patras and Thessaloniki for physics students as well.

At the University of Athens, mathematics students take probability in the second semester of the second year, stochastic processes in the second semester of the third year, and statistical inference over the whole fourth year. The students majoring in physics take probability and elements of statistics for one semester. Students in biology, geology and chemistry take elementary probability and statistics in their second year for one semester as an elective, and pharmaceutical students do likewise in their first year. Interestingly enough, in the Faculty of Law, there is a chair of economic statistics, and the holder of the chair gives a one-year course in statistics. This is just beginning to take place in American universities. In the Medical School, descriptive statistics is given in the first semester of the first year, by a professor of epidemiology.

At Patras, mathematics majors take probability for the whole of their second year and statistical inference for the whole of their fourth year. Physics majors take probability in the second semester of their first year and are required also to take it in the second semester of the second year. Biology students must take biostatistics in the first semester of the second year, and can elect to take another semester in the third year. In the School of Engineering, practically all students take elements of probability in the second semester of the first year and one semester of statistics in the second year. For the first time this year, students in the Medical School take a one-semester course in statistics.

At Thessaloniki, math students take statistics and probability in their fourth year. For medical students, statistics is obligatory in the first year.

At the National Polytechnic of Athens, there is a one-year course in probability in the second year, and at the new University of Thrace, students take a one-year course in probability and statistical inference that is taught by a professor of civil engineering from the Polytechnic in Athens. Applied statistics courses are also taught, usually of one year duration, but required, in the School of Commerce in Athens, the Agriculture School in Athens, and the School of Industrial Studies in Athens.

Some of the student bodies are quite large. For example, at Thessaloniki there are 30,000 students, including 1,200 math majors. This is typical also at Athens.

In the Spring of 1978, the universities have not been operating. The students have been on strike for what might be described as the right to have more participation in the programs of their respective departments, and the department assistants—essentially junior faculty and research associates—have been on strike for what might be described essentially as better working conditions. At times the students have also been on strike to support the demands of the department assistants. The strike is essentially not a general student strike, although it appears that way. Participa-

tion in the strike is usually accomplished by adherence to a political group. The same is true for the women's rights movement in Greece. However, the effect is to provide a total student strike. The strike and the politicization of the students seem to have caused great government concern as to how to handle the situation. What does seem in prospect is that the students may, in effect, lose one year of school.

Because of the competition to gain places in the university which can be accomplished only by scores on national university entrance examinations, a substantial number of students go to other countries to study, Italy being a big recipient because of its proximity to Greece. The competition has also given birth to a large number of training schools which prepare high school students for the national examinations, and in this way provide employment for college graduates that is usually more lucrative than regular high-school teaching jobs. The government hopes to modify this manner of entrance into universities by 1980, when essentially performance in high school will be a deciding factor. However, it is an open question as to whether, or in what form, this will be accomplished.

Statisticians find professional outlet through the traditional statistical societies and their journals, and the Greek Mathematical Society. This Society publishes journals and holds frequent seminars. Because of travel constraints, most of the activity takes place in Athens. However, the present President of the Society is Professor Nicolas Artemiadis, an analyst, who is at the University of Patras. The Vice-President of the Society is Professor E. Galanis, of Athens, who works in harmonic analysis. (Herbert Solomon)

AMERICAN RESEARCH ON EGYPT, IN EGYPT

The American Research Center in Egypt (ARCE) was established in Cairo in 1948 for the purpose of assisting American scholars to conduct research on Egyptian civilization—both ancient and modern. Although ARCE itself employs not more than a dozen full-time staff members, it acts in the key role of coordinator of much, if not most, American-sponsored research in Egyptology and Islamic history. Its support is largely derived from special ("blocked") foreign currency funds which are administered by various US Government agencies under Public Law 480. These agencies include the State Department's Bureau of Educational and Cultural Affairs, HEW's Office of Education, the National Science Foundation, and, to a larger extent, the Smithsonian Institution. Private agencies such as the Bolligen Foundation, the Ford Foundation, and the National Geographic Society also support the Center. In recent years, both Exxon and Coca Cola have contributed hard currency funding for certain ARCE projects. Over the next few years, as PL 480 funds become depleted, the center will require increased hard currency funding to carry out its research programs.

In addition to a series of museum catalogs, monographs, and translations of Islamic works, ARCE publishes a quarterly Newsletter which keeps subscription members apprised of the Center's activities. This Newsletter, which typically runs to about 60 pages, contains news of current ARCE sponsored projects together with announcements of meetings, books, exhibitions, etc. The institutional membership of ARCE ($500/year) is comprised of American and Canadian universities and museums. Individuals from all nations who are interested in the scholarly research of Egypt and its culture may become members for an annual fee of $20.

Most of the ARCE funds are used to provide fellowships for research in Egypt. The Fellows are chosen by an ARCE Committee composed of senior scholars in the humanities, social sciences, art, and archaeology specific to Egypt and the Middle East. Normally, the Center is able to support directly about two dozen Fellows per year.

The specific reason for my visit to the Center was to learn about the Project in Medieval Islamic Astronomy. The objectives of this project are to

explore the detailed astronomical and mathematical methods used by the medieval Muslim astronomers and to investigate the extent of medieval scientific contact between Islam and Europe. I was welcomed by the Director of ARCE, Dr. Paul Walker, who provided an overview of the Center's activities. Later we were joined by Dr. David A. King, the Director of the Medieval Islamic Astronomy Project.

The scholarly credentials of Walker and all the researchers associated with ARCE are quite impressive. King, for example, received his BA and MA degrees in mathematics at Cambridge, a Diploma of Education at Oxford, and, in 1972, a PhD in Near Eastern Languages and Literature from Yale. His principal collaborator since November 1976 is Dr. Edward Kennedy who is on leave from his long-held position as Professor of Mathematics at the American University in Beirut. Over the past 25 years Kennedy has published 6 books and over 80 articles on various topics relating to astronomy and mathematics in medieval Islam. In addition to King and Kennedy, who reside in Cairo, Dr. Owen Gingerich, an astrophysicist at the Smithsonian Astrophysical Observatory (Cambridge, Mass.) and Professor of Astronomy and History of Science at Harvard, is the Principal Advisor to the Project.

In the following paragraphs I shall try to give some idea of the Project's methods and objectives, and the toil and frustrations of this undertaking. As King pointed out, all our present knowledge of the Islamic contribution to the history of the exact sciences is based upon the relatively small proportion of Islamic manuscript sources housed in European libraries, since it is essentially only these sources that have been studied in the past two centuries. However, the largest and probably the richest collection of medieval scientific works in the world is in the Egyptian National Library in Cairo which contains *several thousand* such works—in Arabic, Persian, and Turkish—that until now had never even been cataloged! Many of these manuscripts are from the 9th to 15th century, when Muslim scholars were the leading scientists of the world. This collection contains manuscripts not only from Egypt, but from areas as distant as Morocco, Turkestan and the Yemen.

The initial phase of the work began when King arrived at the Center in Cairo in October 1972. He developed the necessary contacts in the area and helped reach an agreement between ARCE and the Egyptian Under-Secretary of the Ministry of Culture and Information (who has jurisdiction over the Cairo manuscripts) regarding the nature of the research to be performed and the mode of publication of the results. This agreement, signed in June of 1973, stipulated that the work of cataloging could begin in September of that year, that the catalog be prepared in Arabic, and that it be submitted to the Egyptian National Library for publication. Owing to delays caused by the outbreak of war in October 1973 and in the transfer of all the Cairo manuscripts to the new building of the National Library, access to the manuscripts was not actually granted until June 1974—nearly two years after the initial request.

During the intervening period from October 1972 to June 1974, King devoted himself to a thorough study of the methods of astronomical timekeeping in medieval Islam. This study brought to light and described the tables that were used in the major centers of Islamic civilization in the medieval period and traced their development from the most rudimentary examples compiled in Abbasid Baghdad through the very sophisticated tables used later in Cairo and Damascus.

In this effort, King used the computer facilities at the American University in Cairo to deduce the underlying formulas and the astronomical and geographical constants which had been used by the Islamic scholars who originally constructed the astronomical timekeeping tables. Once the underlying equations and parameters had been determined, the mathematical tables found in medieval sources could be readily recomputed and checked for accuracy and consistency. The results of this research have been reported by King in a series of papers published over the past five years.

The monumental task of sifting through and cataloging more than 5,000 astronomical and mathematical works in the Library finally began in July of 1974. This involved reading, abstracting, and classifying each work according to the nature of its contents. The collection was divided into eight major divisions (e.g., general astronomical

works, astronomical handbooks with tables, astronomical instruments, etc.) and each major division was further subdivided into eight subcategories. King was helped by three assistants in copying extracts from the manuscripts. (One should bear in mind that in a poor country like Egypt, photocopying machines are virtually nonexistent and that to "copy" means to do so by hand.)

After undergoing several drafts, the final catalog (in Arabic) amounts to nearly 3,000 typed pages. It consists of two main parts: A listing of the entire scientific collection according to the library classification system adopted and a description of the material contained in the manuscripts arranged chronologically according to subject. Indices of authors, titles, copyists, owners, readers, and dated manuscripts are included. A large number of especially interesting plates are also included. This catalog has been turned over to the Egyptian National Library which has tentatively agreed to the publication of a series of photo-offset reproductions of some of these important scientific manuscripts. In addition to the Arabic catalog, a 1,000-page English-language survey of the collection was also prepared.

Of course, for King and Kennedy, the completion of the cataloging of the massive Cairo collection is only the beginning of their longer-range research goals. Currently, they are preparing descriptive monographs and papers that describe manuscripts or groups of manuscripts in the collection found to contain material not previously known to exist. These will be submitted to the leading international journals of the history of science and of Islamic studies. In the future, King and Kennedy plan to continue the series of monographs started during the first phase of the Project and to include further studies of selected topics that are of considerable interest to the history of science. One specific study which they would like to undertake and which, at the very least, will be of interest to naval historians is a systematic investigation of the navigational techniques and instruments used by medieval Islamic sailors.

Those readers interested in more information about ARCE or the Medieval Islamic Astronomy Project in particular are encouraged to write directly to: American Research Center in Egypt, 2, Midan Kasr El Dubbara, Garden City, Cairo. (William J. Gordon)

LLOYD'S, INTERACTIVE GRAPHICS AND FINITE ELEMENT DATA PREPARATION

Almost everyone has heard of Lloyd's of London, but probably not everyone realizes that there are two separate and distinct Lloyd's firms. I didn't. There is the insurance society popularly known as Lloyd's of London that consists of more than 6000 individual underwriters. Lloyd's of London is world famous for insuring against almost any risk. Then there is Lloyd's Register of Shipping which is a world-famous ship register and shipping classification society. The people of Lloyd's Register have the task of determining whether a ship is properly outfitted and structurally sound. My visit was to Lloyd's Register and my host was Mr. John Short, Technical Programming Manager.

Several years ago Lloyd's Register decided to adopt finite element analysis of ship structures rather than depend entirely upon classification rules and classical methods for certification. NASTRAN, the NASA-developed finite element analysis program, was adopted and developed into a system for the analysis of ship structures called LRSAFE (Lloyd's Register Ship Analysis using Finite Elements). The huge volume of accurate data required for finite element analysis of ship structures placed a considerable burden on the Lloyd's surveyors when hand preparation was attempted. For example, a typical three-dimensional finite element model of a length of a ship may require 12,000 input cards.

In late 1971, Lloyd's Register placed a study contract with a consulting firm to assess, in depth, various methods of reducing the work required in data preparation. The results of the study showed that an interactive graphics solution was most promising. A contract for the development of such a system was placed with Graphical Software Systems in late 1972. A unique feature of the development was a detailed application specification developed jointly by Lloyd's and the designers of the system. Before acceptance by Lloyd's, each feature of the system was validated against the application specification. In a number of cases the designers voluntarily exceeded the application specification without additional cost to Lloyd's. The viability and worth of this technique is proved by the success of the system which was delivered in late 1974 and accepted on 1 January 1975.

The interactive graphics system developed for Lloyd's called ICON (Interactive Creation Of NASTRAN) is based on a DEC PDP 11/45 with 64K core, floating point processor, and dual RK05 discs. Peripheral equipment includes a card reader and a TU10 9 track 800bpi tape drive for compatibility with the IBM 360/158 on which NASTRAN is run. The graphics display is a Vector General 3D3 with joy stick, light pen, and alphanumeric keyboard. The system, written in assembly language, runs under the DOS operating system but will also run under RSX 11-M.

It is evident that the design of the system has been carefully thought out and executed. The experience of one of the designers, A. Armit, in developing Multipatch and Multiobject is quite evident. The system, which was graciously and expertly demonstrated by Ms. Carole Clarke, uses the light pen as the principal interactive device. Confirmation of light pen actions occurs through the space bar on the keyboard. Precise numerical information is entered from the keyboard. The joy stick is used to take advantage of the 3D hardware rotation capability of the Vector General 3D3 display. Full manipulative capability is provided through the light pen. Some representative commands are replicate, substructure, move, delete, etc. The system shows excellent attention to user interaction and psychology.

The system may be used in three ways: to develop the finite element model of the structure from scratch, to display and upgrade or add detail to finite element representations developed automatically on the IBM 360/158, or to display the results of a NASTRAN calculation. The last is a recent in-house development by David Porritt of Lloyd's. When ICON is used to create a finite element model, the end product is a set of NASTRAN cards on magnetic tape. Facilities are provided for viewing the card formats on the display. Full syntax, reference, and error checking of the cards is provided, and a number of display options for viewing and correcting cards are available to the user.

Lloyd's Register feels that the system is very successful. In fact, they ordered identical hardware and a modified software system for use in offshore (oil rig) ocean engineering before the original system was fully operational. Because each individual Lloyd's surveyor may only do one or two ships or offshore structures each year, Lloyd's uses specially trained personnel to operate the system. Reductions in data preparation time are typically from three weeks to three days for an offshore structure. This represents a significant reduction in cost. However, Short emphasized that in the very competitive offshore oil industry the ability to respond to customer needs in much shorter times was equally, if not more important than cost.

The ICON system and its sister, Ocean Engineering System, are excellent examples of cost-effective, productive interactive graphics applications. (David Rogers, U.S. Naval Academy)

PHYSICAL SCIENCES

LASER RESEARCH AT ST. ANDREWS

Most people think of golf when St. Andrews, Scotland, is mentioned. However, I traveled there to look at some very interesting laser research in progress in the Physics Department of the University of St. Andrews. St. Andrews is a small town of about 12,000 people set on the east coast of Scotland fifty miles north of Edinburgh. It has a rich recorded history dating back over 1000 years. The University, founded in medieval times, is now, along with golf, one of the major activities of the town. It has over 3000 students taking courses in Pure Science, Medical Science, Arts, and Divinity.

I visited the Physics Department about ten years ago and found that there were three key staff members involved in laser research. The same three people, Dr. Arthur Maitland, head of the laser group, Dr. Malcolm H. Dunn and Dr. Anthony L.S. Smith, are still there and still very active. There are three other research fellows working in the laser group: Brian Norris, Henry Shields, and Dr. Raymond D.H. Brown. This is a small group, but it has been productive. For example, Maitland and Dunn have collaborated on a book on lasers [*Laser Physics*, North-Holland Publishing

Company, Amsterdam (1969)], the second edition of which is dated 1977 and is now available. The general areas of interest of the group include: development of new lasers, improving laser performance, and the use of lasers as high resolution spectroscopic sources.

Maitland is currently working on high-power argon-ion laser development for laser damage studies. He expects to attain a useful power level of at least 150 W cw. In addition he is conducting experiments in micro-analysis of surfaces using lasers. A Q-switched ruby laser beam is focused onto a surface of the material to be analyzed. Some of the atoms in the ejected plasma are excited and hence fluoresce. A spectroscopic analysis of the fluorescence provides information on the composition of the surface material. A third area Maitland is interested in is excimer lasers. He is investigating the possibility of cw operation.

Smith is looking at the effects of negative and positive ions in CO_2 and CO lasers. These effects are very important in regard to the efficiency of flowing or sealed-off lasers and tube life of sealed-off systems. No one has as yet experimentally determined the presence of negative ions in transverse excited atmospheric pressure (TEA) lasers, but these are expected to exist and should cause discharge instability and arcing. Negative ions, principally NO_2^- and NO_3^-, have been observed recently by other investigators in the flowing afterglow of a cw discharge in a low-pressure ($\sim$1 Torr) mixture of CO_2, N_2 and He. This pressure is lower than that used in either cw CO_2 lasers (10-20 Torr) or TEA lasers (1 atm); however, the results serve to provide a check point at one pressure for theoretical models. In a recent paper [H. Shields, A.L.S. Smith and B. Norris, *J. Phys. D: Appl. Phys.* 9, 1587-1603 (1976)] the results of calculations based on a computer model of a TEA CO_2 laser are described in which 63 neutral and negative ion processes are considered for a sealed tube containing a mixture of CO_2, N_2, O_2, CO, H_2, and H_2O. Their model predicts that in a CO_2, N_2, He mixture the dominant negative ion should be CO_3^- with a total concentration of negative ions up to 10% of the electron concentration depending on the CO_2 concentration. When the dissociation products CO and O_2 that would be present in a sealed-off system are included, the dominant negative ion is CO_3^- and the ratio of negative ion concentration to electron concentration increases to $\sim$1 for a mixture rich in CO_2 such as that used in uv-preionized lasers. The effects of the additives CO and H_2O were also investigated. The CO reduces the CO_2 dissociation and therefore the amount of O_2 while H_2O in small amounts also limits CO_2 dissociation as well as aiding preionization.

Smith and his colleagues experimentally verified that long-life sealed-off TEA laser operation can be obtained in a mixture of CO_2, N_2, He provided the O_2 concentration is less than 0.5-2.0% and the water vapor concentration is less than 1-3%.

Smith's group has also made theoretical and experimental investigations of positive ions in CO_2 lasers. They developed a semiquantitative reaction kinetic model to explain the formation of positive ions observed in the positive column of discharges of CO_2, N_2, He, H_2 mixtures.

An additional important topic pursued by Smith's group is the CO laser. This work is highly significant as they reported room temperature transverse-excited operation at pressures up to 1 atm with sliding-spark uv preionization in a sealed-off CO-He laser. Previously room temperature operation was possible only with large and expensive electron-beam excitation equipment. Also an order of magnitude improvement in peak power per unit volume over other workers' results was achieved. They obtained $>10^5$ pulses over a period of two weeks with no significant decrease in power or output.

The elimination of the necessity of a flowing system also reduces the cost and increases the practicality of CO lasers. Smith feels that there is room for improvement of his system, and he predicted that it should be possible to produce CO lasers of very high efficiency.

Dunn's group has recently been working on second-harmonic generation of cw dye-laser radiation, detection of Rydberg states, and measurements of electron and metastable He densities in hollow-cathode discharge metal vapor lasers. They have developed a tunable frequency-doubled cw dye laser using an intracavity ammonium dihydrogen

aluminate (ADA) nonlinear crystal. A power of 30 mW is obtained over the range 2920-3020 Å with a 6-W argon-laser pump. They have been concerned about losses introduced by intracavity nonlinear crystals and have designed a cavity to compensate for astigmatism and coma produced by the Brewster-angle crystal surfaces. Three cavity configurations using off-axis mirrors have been designed which offer various degrees of compensation.

Dunn has used the uv cw dye laser to excite Rydberg states in Rb atoms. P states are excited directly up to n = 74. The group has developed a new sensitive way of detecting Rydberg states. The atoms are excited in a space-charge limited thermionic triode between the grid and anode. A small electric field applied to the grid permits detection of these states, which are only a few meV from the continuum, by the resulting collisional ionization with ground-state Rb atoms and subsequent current produced in the anode circuit. Additionally an electric field of <5 V/cm applied to this region causes Stark broadening resulting in a mixing of excited states and allowing the *normal selection rule*, $\Delta\ell = \pm 1$, to be broken and allowing excitation of ^2S and ^2D states as well. They have observed ^2S states from n = 39 to n = 53 and ^2D states from n = 37 to n = 54. Term levels and quantum defects are easily determined. An indication of the sensitivity of this technique can be gained by realizing that the original detection of Rydberg states by an absorption method required an absorption length of 28 m and an integration time of 10 hours. Dunn's method requires an absorption length of a few cms and integration times <1 sec.

A laser heterodyne system has been developed by I.K. Belal and Dunn to study processes in metal vapor lasers by measuring electron densities in a hollow-cathode discharge. The beat frequency between two He-Ne lasers, one of which contains the discharge within its cavity, is measured as the discharge is switched off. The index of refraction of the plasma changes when the discharge is in operation by an amount dependent on the electron density. The change in index produces a change in beat frequency.

Electron densities of 10^{13}-10^{14} cm^{-3} were measured confirming that the hollow-cathode discharge is superior to a positive column discharge for creating excited metal-ion states in charge exchange between He ions in their ground state and neutral metal atoms.

This relatively small laser group has been quite productive through the years and should continue to produce good results in the years ahead. (Vern N. Smiley)

MAGNETOHYDRODYNAMICS AT THE BEN-GURION UNIVERSITY OF THE NEGEV

An interesting program in magnetohydrodynamics (MHD) is being developed at the Ben-Gurion University of the Negev in Beer-Sheva, Israel. The formation of the University in order to spearhead the development of the Negev desert region was the ambition of the late, former Prime Minister David Ben-Gurion, and so it was named in his honor. The director of the MHD program is Professor Herman Branover, who first arrived in Israel in 1972. Previously, he was in the Physics Institute of the Latvian Academy of Science in Riga, USSR. That Institute then and currently consists of some 400 scientists, engineers, and technicians who are active in research on liquid metal MHD. The MHD activity in Beer-Sheva is part of the Mechanical Engineering Department of the University.

Magnetohydrodynamics is the study of the interaction of the flow of an electrically conducting fluid with electromagnetic fields. A simple example of this phenomenon is obtained by considering the flow of a conducting fluid in an easterly direction with an ambient magnetic field in the northern direction. An electric field will then be present in the flowing fluid and will be oriented in the vertical (upward) direction. Faraday proposed, in this way, to measure the flow in the Thames River even though the ambient (earth's) magnetic field was weak. The example also serves to illustrate the *modus operandi* of the ordinary dc MHD generator. Of course, very few things are really simple and so the dc MHD generator is also complicated by a number of secondary effects. For instance, the electric current induced in the fluid as it moves through the ambient magnetic field also serves to modify the field. The better an electrical conductor the fluid is,

the greater the induced current and the greater the modification to the ambient field.

The activities of the MHD program at Beer-Sheva are confined principally to liquid-metal MHD (LMMHD), for which the experimental facilities are considerable. There is an instrumented MHD channel which is 2 cm × 9 cm in cross section and 2 m long. A transverse magnetic field up to 1 Tesla (10,000 G) can be supplied with flows of liquid mercury in the channel of Reynolds numbers up to 150,000. The varied instrumentation used in the channel includes hot film and 2-electrode probes for obtaining the induction potential difference.

An MHD generator in the laboratory is used for single- and two- phase flow experiments. The working fluid is either mercury (single phase) or mercury and argon (two phase) with flow Reynolds numbers up to 500,000. The applied transverse magnetic field can reach 1 Tesla. The dimensions of the generator channel are 1 cm × 2 cm × ½ m long. The generator can be operated with conducting and nonconducting partitions, and observations of pressure, voltage, current output, and void fraction distribution can be made.

A traveling wave magnetic-field open-channel 10 cm wide and 1 m long has been completed and is now operating. The working fluid is mercury. Three-phase, 50-Hz ac current is supplied to the traveling wave magnetic-field windings. Since the field's wavelength is 10 cm, its phase velocity is 5 m/sec. The device operates at high slip with the velocity of the mercury variable from 10-50 cm/sec.

A NaK (Sodium-Potassium) facility for the study of single- and two-phase MHD flows is under construction. The flow capacity is 25 liters/sec; the field strength is 1.6 Tesla for a 2.75-cm gap. The pressure that can be supplied in the loop is a head of 25 m of the working fluid. The pole pieces are 1 m long. It is hoped that this loop will also serve as a pilot plant for solar MHD.

The research activities of Branover's group are reported in a companion article on "The Second Bat-Sheva Seminar of MHD Flows and Turbulence" which follows.

I was impressed with the activity in LMMHD at Ben-Gurion and with the enthusiastic group of researchers and students that Branover has assembled particularly in view of the short time he has been in Israel.
(Martin Lessen)

THE SECOND BAT-SHEVA SEMINAR ON MHD FLOW AND TURBULENCE

The Second Bat-Sheva Seminar on MHD (Magnetohydrodynamic) Flows and Turbulence, sponsored by the Bat-Sheva de Rothschild Foundation for the Advancement of Science in Israel, was held from 28-31 March at the Ben-Gurion University of the Negev in Beer-Sheva. The organizing committee consisted of well-known individuals from the United States, England, and France as well as Israel, and was chaired by Prof. Herman Branover of the Mechanical Engineering Department of the Seminar host institution. The Bat-Sheva de Rothschild Foundation has sponsored some thirty previous scientific seminars in areas ranging from genetics of microorganisms through quantum fluids, marine geochemistry, molecular dynamics in liquids to interaction of art and science, although it has as its primary function the support of immigrant scientists and young scientists through grants-in-aid and grants for research, respectively.

The subject matter of the Seminar was naturally split between MHD flows and turbulence; the MHD part of the program was mainly concerned with liquid metal flows, while the sessions on turbulence were devoted to both MHD and ordinary non-MHD turbulence. Considerable attention was given to two-phase (liquid metal + gas) direct-current power generation and MHD applications for liquid metal casting in foundries and metal processing mills along with preparatory investigations of liquid lithium flow in the intense magnetic fields of projected nuclear fusion reactors.

In the area of two-phase MHD power-generating flows, T.A. Trovillian, U.H. Kurzweg, R.E. Elkins, and E.R. Lindgren (Univ. of Florida at Gainesville) pre-

sented the algorithms for flow in a rectangular duct with a transverse magnetic field having a void fraction (ratio of gas to total volume) that varied over the cross section of the duct so that very little gas was present near the walls and a considerable amount was in the center. Since the resulting variation in electrical conductivity adversely affects efficiency, the addition of partitions placed parallel to the channel walls was considered so that the void fractions could be more evenly distributed. The partitions parallel to the nonconducting duct walls were insulated, while the partitions parallel to the electrode walls were conducting (See Fig. 1). It was found

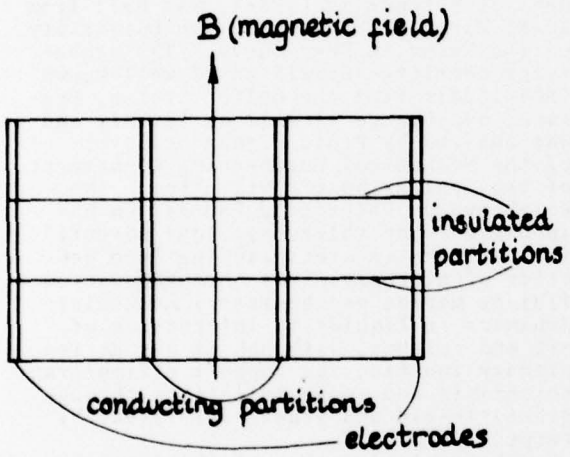

Fig. 1. CROSS SECTION OF PARTITIONED MHD DUCT

that the reduction in flow rate due to the partitions was small while the general effect on performance was favorable. The effect of a shunt layer in liquid-metal two-phase MHD generators was discussed by Prof. P.S. Lykoudis (Purdue Univ.). The shunt layer arises because the flow at the nonconducting walls is zero although the boundary layer is very thin, and thus the shunt serves as a short circuit between the electrode walls. However, for a typical generator, the resulting losses were calculated to be small. The effect of small, nonconducting streamwise baffles parallel to the conducting walls and located in the middle of the channel's nonconducting walls was discussed in a paper by A. Yakhot, E. Hock, A. Levin and H. Branover (Ben-Gurion Univ.), who found theoretically that the baffles could increase the output of such a channel (See Fig. 2). A study of turbu-

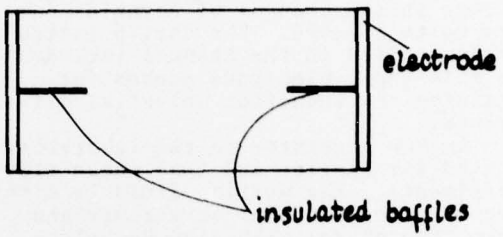

Fig. 2. ELECTRODE WALL BAFFLES IN DUCT CROSS SECTION

lent flow in MHD generator channels by Branover, E. Hoch, A. Landsberg, Y. Unger, and A. Zilberman (Ben-Gurion Univ.) revealed increased turbulence in the fringe (entrance) region with increasing transverse magnetic field strength. The reason for this seemed to be that in the fringe region, the velocity distribution has maximum values near the walls and therefore has points of inflection that lead to instability and turbulence. The effect is caused by the presence of the magnetic fringe field and is enhanced with the increase in field strength.

P.F. Dunn, G. Fabris, E.S. Pierson, and M. Petrick (Argonne National Laboratory, Argonne, Illinois), reported on studies of NaK + N_2 (Sodium-Potassium + Nitrogen) and Na + N_2 with a foaming agent in the MHD channel flow. The problem with a foaming agent is that while it keeps the bubbles alive, it also makes separation of the gas phase from the liquid phase difficult. The search is on, therefore, for a foaming agent with "champagne" characteristics such that the bubbles will break down when they are no longer needed. Various possibilities for bubbling and separating geometries were discussed. Papers on Solar LMMHD (liquid-metal MHD) by R. Radebold (Technical Univ.

of Berlin) and I. Borda, Branover, A. Elbocher, and A. Leitner (Ben-Gurion Univ.) held out hope of practical though inefficient systems on the basis of ordinary considerations; on a cost basis, however, the systems looked favorable compared to photovoltaics. E. Tate and B. Zauderer (General Electric, Philadelphia) described theoretical and experimental work on self-excited, pulsed MHD power-generation. An electrically driven shock tube was used to produce a plasma which, under the influence of a "tickling" permanent magnet that provided the initial Faraday voltage, then provided the magnetic field exciting current for the generator. It was observed that irrespective of the plasma conductivity, sufficient initial induced voltage via the "tickler" magnetic field is required to overcome electrode voltage drop for this to initiate power generation.

Review lectures in the general area of LMMHD duct flow were given by G.S.S. Ludford (Cornell Univ.) on the basic theory and A.J.C.R. Hunt (Cambridge Univ.) on theoretical and experimental applications. H.K. Moffat (Univ. of Bristol, UK) presented an MHD generalization of the G.I. Taylor theory of streamwise diffusion in duct flow. A transverse magnetic field with respect to the streaming direction flattens the velocity distribution and hence reduces the streamwise diffusion. The effect of duct wall conductivity on LMMHD flow was reported by P. Tabelin and J.P. Chabrerie (Univ. of Paris), and the theory developed was found to check previous known results asymptotically. The application considered was nuclear fusion reactor design. Because liquid lithium exhibits a large thermoelectric effect, its use as a coolant for a reactor would involve the presence of large thermoelectric currents with possible deleterious effects. Accordingly, J.A. Shercliff, C.J.M. Alty, and P.B. Dutta-Gupta (Warwick Univ., UK) developed the relevant algorithms for thermoelectric MHD and reported on the order of magnitude of these effects. I.R. McNab (Westinghouse, Pittsburgh) described the Westinghouse NaK MHD facility and some of the experiments in progress. Flow rates up to 22 liters/sec in four parallel rectangular ducts each 18 mm × 56 mm in cross section with magnetic fields up to 1.23 Tesla can be achieved. Currents up to 16 kA can be provided to the channels.

The most immediate application of LMMHD lies in metal processing, and this is already being practiced in the USSR. There is considerable research activity in this area in Western Europe, the US, and Israel in the direction of heating the liquid metal while pumping and stirring it. G.S.S. Ludford reported on work with J.S. Walker (Univ. of Illinois, Urbana) on open-channel flow of MHD-driven liquid metals. Theoretical solutions for driven and throttled flows were obtained that have application in pumps, flow meters, and slag separators. F.R. Block (Technische Hochschule, Aachen, FRG) reported on a traveling wave magnetic-field flow control experiment of the continuous casting of steel carried out in cooperation with the Innocenti S[illegible]teristacchio plant in Brescia, Italy. He also stated that a 1-kg glob of molten alu[illegible]um was levitated by using alternating fields. An invited lecture by R. Moreau (Univ. of Grenoble, France) described the use of rotating magnetic fields to heat and stir liquid metal in the continuous casting process. The stirring keeps the constituents of the melt homogeneously mixed and inhibits the formation of large crystals and other structures during solidification.

Other papers in the area of LMMHD were Pitot Tube Theory by E. Berger (Technical Univ. of Berlin); Instability of a Free Surface Driven by Alternating Magnetic Fields by A. Marcel, A. Garnier, and P.P. Garnier (Univ. of Grenoble); Baroclinic Instability in the Presence of a Magnetic Field by Y. Fautrelle (Univ. of Grenoble); and Inertial Convection in Liquid Metals by M.R.E. Proctor (Univ. of Cambridge, UK). Proctor obtained an elegant, closed form solution to the lowest mode of convecting flow in a horizontal cylindrical tube for a non-MHD flow. G. Schouten (Technical Univ. of Delft, The Netherlands) spoke about boundary-layer theory at the entrance to the magnetic-field region in an MHD channel. G. Thatcher (UK Atomic Energy Authority) presented a review of LMMHD work in progress at the Risley Nuclear Power Development Laboratory that entails work in induction pumps, flux distortion flowmeters, and EM flow couplers for the primary and secondary flows in heat exchangers for breeder reactors.

The section of the Seminar devoted to turbulence contained review lectures by F.N. Frenkiel (Naval Ship R&D Center, Bethesda, MD) on recent directions in experimental turbulence studies and M. Lessen (ONR London) on the marginal instability of turbulent flow. P.F. Klebanoff (National Bureau of Standards, Gaithersburg, MD) and Frenkiel reported on an experimental investigation of small-scale turbulence structure in air and water downstream of a grid and in a boundary layer over an extended range of Reynolds numbers. D. Oster, B. Dziomba, H. Fiedler, and I. Wygnanski (Univ. of Tel Aviv. and Technical Univ. of Berlin) presented the results of a study of the effect of trailing edge oscillations on the spread of a two-dimensional mixing layer that indicated the layer would initially spread at a faster rate than the undisturbed case but would eventually (in the far field) spread at the undisturbed rate. The higher the frequency of oscillation, the nearer downstream did the shearing layer return to the undisturbed rate of spread. J. Amini (Univ. of Grenoble) presented the results of an experimental investigation of the development of a turbulent spot. Amini's data indicated that a single spike in the fluctuation within the turbulent burst develops into multiple spikes farther downstream. The model of a secondary instability caused by the interaction of the primary instability and the principal flow also seems to fit the data. G. Fabris (Argonne National Laboratory) discussed the conditional sampling of the turbulent wake of one and two cylinders. M. Wolfshtein (The Technion, Haifa) discussed the influence of the structures of turbulence on the Prandtl number for turbulent energy while D. Naot (Center for Technological Education, Holon, Israel) presented some thermodynamic aspects of anisotropic turbulence.

In the area of MHD turbulence J.C.R. Hunt, M.R. Maxey, and R.J. Holroyd (Univ. of Cambridge) discussed the estimating of turbulent shear stresses in the presence of low-frequency electromagnetic fields. P.L. Sulen and U. Frisch (The Observatory, Nice, France) and A. Alemary and R. Moreau (Univ. Grenoble) gave results of a theoretical and experimental investigation into the influence of an applied magnetic field on homogeneous MHD turbulence. A. Pouquet and U. Frisch (The Observatory, Nice) spoke on strong MHD helical turbulence and the dynamo effect, while P. Plaschko reported on theoretical investigations of three-dimensional disturbances of MHD jets with an aligned magnetic field.

Though not central to the liquid metal theme of the Seminar, S. Lederman (Polytechnic Inst. of New York) nevertheless presented an enlightening paper on laser scattering in flow field diagnostics. He discussed elastic and inelastic photon scattering and showed how concentration and temperature of ionized and unionized species along with velocity, turbulence intensity, and cross-correlation parameters could be obtained simultaneously and nonintrusively.

In all, the Seminar (proceedings of which will be published) was highly successful in that the participants arrived with their own ideas and left with many more. The Chairman, Prof. Herman Branover, and entourage deserve many kudos for their excellent organization and the skillful running of the meeting as well as the effort expended in making the visiting firemen welcome and comfortable. (Martin Lessen)

PSYCHOLOGICAL SCIENCES

LEADERSHIP RESEARCH THEMES AT A SYMPOSIUM ON MILITARY PSYCHOLOGY

The research communication channels for military psychology in the West are kept open by the International Symposium on Applied Military Psychology, and the 14th annual meeting was held on 17-21 April 1978 in Florence, Italy. ONR London is the agency that maintains the continuity of the meetings, with the main work each year being done by a different host country. This year the host was Italy, with Col. Dr. M. Stracca in charge. Thirty-seven behavioral scientists from 13 countries presented a full program of papers. Rather than try to sketch all of these papers, it would seem useful at this juncture to review leadership research themes that arose; leadership was a main topic of the Symposium. The full details of the proceedings will appear in an ONRL conference report at a later time.

The leadership domain that dominated the discussions was infantry, which is appropriate because the West has several million men in this fighting arm. An infantry leader is a classic kind. The basic skills of the followers involve relatively simple weapons and tactics, and the leader will know them better than the men. Beyond the basics which the followers know, the leader's knowledge includes a conceptual grasp of larger-scale tactics and strategy, and he understands complex weapons like artillery and air. Combat leaders of small infantry units, such as the platoon or the squad, may often lead in the literal sense of being out in front. Truly an infantry leader is a man of parts; it is hard to think of anyone who deserves the label "leader" more than he.

The problem with military psychologists dwelling unduly on the infantry model is that many military leaders are required to have dimensions quite unlike the infantry leader, and the winning of wars will depend on them as much as on infantry leaders. A modern military unit can be awash in advanced technology, e.g., missiles, radar, and computers, and it is common today for a leader to supervise personnel who operate and maintain them. In contrast to the infantry leader who can do everything the men can do, the leader of a technologically advanced unit lacks the skills of his followers. He cannot program the computers, fix the radar, or perhaps even fire the missiles. Instead, he is a manager of resources who knows the functional characteristics of the equipment under his command and how to direct his men to use them for the attainment of military objectives. His role closely resembles an industrial manager who organizes resources to achieve production and marketing goals. For whatever usefulness the infantry model has, military psychologists will have to give a larger share of attention to the selection, training, and proficiency measurement of officers who manage far more than they lead.

Leadership training was another conference issue, and it is an area where significant advances probably will not come until psychologists clear the theoretical air. Which of these descriptions is correct?

1. Leadership success is based on a proper combination of durable personality traits. Whether leadership capability is generalizable across situations, or is idiosyncratic, is unclear with this position. Leadership traits might generalize widely, or different combinations of them might be required for different situations. Training is of no importance for this point of view because the required personality traits are durable and relatively immune to change. The research task is to identify leadership traits and the individuals who have them.

2. Leadership is a composite of skills that vary from situation to situation; the skills are idiosyncratic and do not generalize. Being skills, they can be taught and learned, but they must be learned anew for each situation because they do not generalize over a range of situations. The research task is defining the skill elements and the training program that teaches them.

3. Leadership is a composite of a small number of generalizable skills that are the central elements of many leadership situations, and once they are learned they can be employed succesfully wherever command is required. Being skills, they can be discovered through research, incorporated into training programs, and taught.

4. Some combination of the above.

The characteristics of optimum leadership training programs probably cannot be specified until research has sorted out these theoretical accounts. Clearly the training implications of each are different.

A third theme that coursed through the conference was how the selection, training, and proficiency measurement of leaders is validated. What is the criterion of success? The ultimate criterion for military leaders is success or failure in war, but it is a criterion that reasonable people wish to avoid. Even if war did become available, it may be so situation specific and so unstructured (from a research point of view) that meaningful validation would be impossible. Psychologists, therefore, have had to be satisfied with the lesser criteria of peacetime, which is scientifically troublesome because peacetime criteria may be unrelated to wartime ones. Moreover, the longer a country is at peace the more there is adaptation to peacetime ways of operation, and so peacetime criteria become more and more acceptable to us. Increasingly we select, measure, and train leaders for peacetime roles, almost as if we forget what the military is for.

The conferees had no new ideas on validation, but then neither does psychology as a whole, so they cannot be faulted. The replay of the criterion problem may have been tedious for old hands, but it is worthwhile nevertheless. Old tapes may stimulate someone someday to cast off established ways of thinking and come up with something new. (Jack A. Adams)

NEWS & NOTES

PERSONAL

Professor Ian Douglas, Professor of Geography at the University of New England, Armidale, Australia, had been appointed to a Chair of Physical Geography at the University of Manchester from 1 January 1979.

Dr. L.R.C. Haward, Reader in Clinical Psychology in the University of Surrey's Department of Psychology, has been appointed to a personal Chair in Clinical Psychology.

The Royal Institution of Great Britain recently reelected the Duke of Kent as president and Mr. D.P. Thompson as treasurer. Professor H.J.V. Tyrrell, Vice-Principal of Chelsea College, was elected secretary.

Mr. Basil Lythall, currently Chief Scientist (Royal Navy) and Deputy Controller Research and Development for Establishments and Research in the UK's Ministry of Defence, has been appointed the next Director of NATO's SACLANT Antisubmarine Warfare Centre, La Spezia, Italy. He will replace Mr. Sven Falck of Denmark, who has held the post for the last three years.

OBITUARIES

Dr. T.P. Hoar, internationally known for his work on corrosion, died on 6 May at the age of 71. After receiving his PhD in 1933, he continued on at Cambridge University combining research and teaching and laid the foundations of a consulting practice. Until the outbreak of WWII, he carried out basic investigations for the International Tin Research and Development Council. After the war, spent in service with the Ministry of Supply, he returned to Cambridge as a University Lecturer and later became Reader in the Department of Metallurgy. He was a foundation member of the Comitá Internationale de Thermodynamiques et de Cinétique, becoming President in 1955. At various times he was President of the Institution of Corrosion and Protection Association, and was probably best known as the Chairman of the Committee on Corrosion and Protection, which issued what became known as the Hoar Report. This pointed out that much money could be saved by the intelligent application of available knowledge.

Reimer Pohlman, a pioneer in the field of ultrasonic techniques, died 2 April 1978. His early work was on various applications of the then new field of ultrasonics, and particularly on problems of ultrasonic imaging of objects. One of the techniques he developed, widely known as the "Pohlman window," can be regarded as the forerunner of ultrasonic holography. From 1948 to 1957 he was with the Technical University Zurich (ETH) where he continued his work in biological and medical applications and also developed new methods for ultrasonic cleaning, welding, and shaping soleds. For the next 20 years, he was Professor and Director of the Laboratory of Ultrasound at the Rheinish-Westphalian Technical University in Aachen and contributed hundreds of publications on ultrasonics. He was the German editor of *Ultrasonics* and founded the Ultrasonic Documentation Center at Aachen.

Professor John George Valatin, Professor of Thooretical Physics at Queen Mary College, University of London, died on 19 April 1978 at the age of 60. Born and educated in Budapest, he began his academic career there at the Technical University as a lecturer in physics. In 1947, he joined Louis de Broglie at the Institut Henri Poincaré, University of Paris where he worked on the theory of the positron. He spent two years at the Niels Bohr Institute in Copenhagen and in 1952 joined the Department of Mathematical Physics at the University of Birmingham. His work moved increasingly toward more fundamental problems, and he did important research on the divergence-free formulation of quantum electrodynamics. However, the research for which he is perhaps best known is probably his discovery of the transformations which may be used to give an elegant description of the superconducting state. He later applied his methods in the study of nuclear physics. In 1965, he took up the Chair at Queen Mary College where he established a group working in the theory of fundamental particles, to which he himself made contributions, as also to condensed matter physics.

ONRL REPORTS

C-3-78 SYMPOSIUM ON FUNCTIONS OF MICROBIAL MEMBRANES, TÜBINGEN, GERMANY, 5-7 SEPTEMBER 1977 by J.E. Sippel

A discussion of some of the papers presented at the Symposium on Functions of Microbial Membranes, which was held at the University of Tübingen, 5-7 September 1977. A complete list of papers given at the Symposium is included as an appendix.

R-1-78 SUPERCONDUCTING MICROWAVE CAVITY RESEARCH AT SIEMENS by F.C. Essig

Information derived from a visit to Siemens AG, Erlangen, FRG, to discuss their work on superconducting microwave cavities is presented. The results obtained with niobium and niobium tin (Nb,Sn) over the last few years are reviewed. Siemens' current interests are to continue work with Nb,Sn, to explore new TM-cavity designs, improve cavity reproducibility and to produce less expensive cavities.

R-2-78 UNDERWATER INSPECTION AND NONDESTRUCTIVE TESTING OF OFFSHORE STRUCTURES by R.L. Brackett

Regulations have been established by the governments of countries bordering the North Sea which require annual inspection of offshore structures. This has resulted in a much more intensive use of Nondestructive Testing (NDT) techniques for underwater inspection than currently exists in the United States. This report presents a review of the NDT techniques and equipment currently used in the North Sea area and discusses some of the research being conducted in the UK and Norway to improve the quality of underwater NDT inspection.